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INVESTIGATIONS IN TRINIDAD ON A PARASITE FOR "CLIDEMIA HIRTA."

By T. H. C. Taylor, Entomologist, Coconut Committee.

CLIDEMIA HIRTA IN TRINIDAD.

A preliminary study of the control of the Melastomaceous shrub, *Clidemia hirta*, was undertaken in November, 1927, and continued until the end of January, 1928, with a view to finding some controlling factor which might be applied in Fiji. Owing to the pressure of other work, and the brevity of our stay in Trinidad, it is impossible to present a full report on all aspects of the problem; but the investigations made were sufficient to show that further work in Trinidad is desirable and might yield results which could be usefully applied in Fiji.

Distribution in Trinidad.

Clidemia hirta is widely distributed in Trinidad, but is rarely seen outside the forests. It was never found on sugar estates, except occasionally in damp ditches near streams. On coconut estates it is very rare and only appears on land which is badly drained. In the moisture of cocoa estates it is a little more common, but never sufficiently so to be regarded as a serious weed. It has never attracted any attention in Trinidad and is certainly of no economic importance there.

In the course of this and other work, nearly all parts of Trinidad, except the south-eastern corner, were visited. The districts in which *Clidemia* was examined included Cedros, and the forest between Cedros and Brighton, in the south-western peninsula; Couva, Pointe a Pierre, and Waterloo Estate, in the west; Maqueripe, in the north-western corner; Sangre Grande, Manzanilla, and the forest at the southern end of the Toco Road in the east; Brasso, San Rafael, and the Arena Forest Reserve, in central Trinidad; and many localities near the main eastern road between Port of Spain and Arima.

Clidemia hirta was found in all these localities, and there is no doubt that it occurs in suitable places all over the island. In the forest areas it is nearly always common, and wet, partially shaded land is certainly its natural habitat. A noticeable feature of its occurrence in the forest is that it occurs more at the sides of clearings, paths, and roads in the forest than in the more densely shaded parts.

The only district other than forest areas, in which it was found commonly is between San Rafael and Arima, on the Tumpuna Road, where there is a wide stretch of dense low scrub. The common occurrence of the shrub here was probably brought about by the lack of a dry season in 1927. Uncultivated country of this sort is unusual in Trinidad, and it is unlikely that *Clidemia hirta* would have flourished in it in a normal dry season. The observations of Urich indicate that the joint effects of its natural enemies and a dry season usually wipe it out in open situations, as pointed out hereafter.

Although *Clidemia hirta* is common in many parts of Trinidad it is never present in large quantities in one locality, but only in the form of isolated bushes. Even in the forest where it is most common, it never forms the

greater part of the undergrowth. The nature of the soil seems to have very little connection with its distribution.

Controlling Factors.

Clidemia hirta is certainly efficiently controlled in Trinidad by natural means. The factors which are responsible for its control are—

1. Climatic conditions.
2. Pressure of other vegetation.
3. Insect enemies.

1. *Climatic Conditions* undoubtedly influence the distribution of *Clidemia hirta* to a great extent. An abundance of moisture is essential to it, and it is much more common and more flourishing in the wet season than in the dry. Although it is always found much more commonly in shady spots than in the open, the degree of shade is only of importance in so far as it concerns the conservation of moisture. *Clidemia hirta* is found in the full sun at the edges of marshes or in ditches, and the plants never suffer from the heat so long as the soil remains wet. Moisture is certainly the most important factor in Trinidad. The cooler climate which prevails at higher elevations seems to favour *Clidemia hirta* a little.

2. *The Pressure of Other Vegetation* must play an important part in the control of this shrub. The fact that it flourishes at the edges of shady paths in the forest and also in the sun round the edge of forest areas, and yet is rare in the undergrowth of the forest itself, supports this view. Further, it frequently appears during the wet season, in ditches which have recently been cleared and had previously been free from it.

3. *The Insect Enemies of Clidemia hirta* are few in number, and no fungal diseases of any importance were observed. There are only two insects which attack it commonly and these are a leaf-rolling lepidopterous larva (probably more than one species) and the thrips, *Liothrips urichi*. The leaf-rolling larvæ attack many other species of Melastomaceous plants, but although common, they are never sufficiently so to cause any material damage to the plants. The thrips, on the other hand, appears to be absolutely confined to *Clidemia hirta* and inhibits the growth of it. The precise extent of its importance in Trinidad as a control for *Clidemia hirta* is very difficult, if not impossible, to estimate, but, of all the factors concerned in the control of this plant, the thrips is the only one which could be applied to Fiji. For this reason a special study of its life history and habits was made in Trinidad, and the results, though incomplete on account of the pressure of other work, were satisfactory as far as they went.

Other Melastomaceous Plants in Trinidad.

There are very many different species of melastomaceæ in Trinidad, most of them belonging to the genera Miconia and Clidemia. The identification of many of them is difficult on account of the great similarity which exists between different species, and in some cases identification is impossible unless the flower can be found. Several species are, at first sight, very similar to *Clidemia hirta*, particularly when they are growing together in the forest. All the common species were examined from time to time in many different parts of Trinidad in order to find out, as far as possible in the time available, whether the natural enemies of *Clidemia hirta* would also attack other closely allied plants and also whether any of the factors concerned in the control of the latter were applicable also to *Clidemia hirta*.

A collection of the common Melastomaceæ (21 species in all) was prepared in Trinidad and brought to Fiji in the belief that it might prove useful to other workers in this field. This collection contains the following species:—

1. *Clidemia hirta*, Don.
2. *Clidemia neglecta*, Don.
3. *Clidemia spicata*, D.C.
4. *Clidemia pustulata*, Schr. and Mort.
5. *Clidemia rubra*, Mort.
6. *Miconia racemosa*, (Aubl.), D.C.
7. *Miconia albicans*, (L.W.), Triana.
8. *Miconia prasina*, D.C.
9. *Miconia chrysophylla*, M'fulva., D.C.
10. *Miconia triplinervis*.
11. *Miconia lacera*, (Boufl.), Nand.
12. *Miconia virescens* (Vahl.), Triana.
13. *Miconia guianensis*, (Aubl.), Cogn.
14. *Miconia minutiflora*, D.C.
15. *Miconia ciliata*, D.C.
16. *Miconia acinodendron*, (L.), Triana.
17. *Miconia fulva*, D.C.
18. *Miconia tomentosa*, (Rich.), G. Don.
19. *Nepsera aquatica*.
20. *Aciotus purparescens*, (Aubl.), D.C.
21. *Oxymeris rufescens*, Triana.

Insects Attacking Other Melastomaceæ in Trinidad.

The results obtained from this preliminary survey of allied Melastomaceæ were mostly of a negative nature but are nevertheless important in some respects. The most significant point as far as Fiji is concerned, is that the thrips, *Liothrips urichi*, never attacks anything except *Clidemia hirta*. (The evidence for this is given hereafter.) The leaf-rolling caterpillars attack nearly all species of Miconia and Clidemia (and probably many other plants in no way connected with these), and therefore cannot be considered suitable for importing into Fiji; moreover, although they are common they are never sufficiently so to play any part in the control of *Clidemia* hirta in Trinidad.

There are many other insects which are found on plants of this family, but, apart from the thrips, only two others appeared to be confined to them. These are, firstly, a Cecidomyid fly which was bred from the flowers of a species of Miconia, and secondly a curious moth, probably belonging to the family Gelechiidæ, whose larva causes remarkable galls in the stems of *Clidemia pustulata*.

The latter insect is abundant, and is absolutely confined in nature to *Clidemia pustulata*. An attempt was made to induce it to attack *Clidemia hirta* in the laboratory, but it would not do so, though further experiments of this nature are desirable. *Clidemia pustulata* is distributed throughout all the forest areas of Trinidad, growing in many places, in close proximity to *Clidemia hirta* and many other species of Melastomaceæ, and wherever it occurs the galls of the Gelechiid moth are present on it. It is, in fact, very unusual to find a plant of *Clidemia pustulata* which is free from these galls, and the stunted, gnarled appearance which the plants nearly always exhibit, is probably due to the larvæ of this moth. The larva lives in the centre of the stem of *Clidemia pustulata* where it hollows out a chamber for

itself, and causes the stem in its immediate neighbourhood to swell considerably. The walls of the chamber are thick and hard, and constitute a prominent oval swelling in the stem. There are usually many of these galls on each plant. There is no hole in the gall until the larva is full-grown, but having reached this stage the larva tunnels through the wall of its chamber to the exterior, closes the hole at the outer end with silk, and withdraws into its cell. It then spins a very tough silken cocoon in the centre of the gall, and pupates within it. The moth, which is not yet identified, eventually emerges through the hole.

The habits of this moth, and its effect on the plant, are very similar to those of another Gelechiid moth, *Phthorimœa* sp., which is a pest of tobacco.

Clidemia hirta and *Clidemia pustulata* appear to be the only Melastomaceæ in Trinidad which have absolutely specific insect enemies, the thrips in the former case and the moth in the latter. It is therefore significant that these two species of Clidemia are always less healthy in appearance and often less common than the many other Melastomaceæ which flourish round them in the forest.

LIOTHRIPS URICHI, KARNY, AS A NATURAL ENEMY OF *CLIDEMIA HIRTA*.

Liothrips urichi belongs to the family Phlœothripidæ and the sub-order Tubulifera, of the order Thysanoptera.

Distribution.

Liothrips urichi occurs throughout Trinidad, wherever Clidemia grows. It is said to be more common in the dry season than in the wet, but we found it all over the island during the wet season. It seems to avoid plants in very deep shade, but otherwise shows no preference.

Indications of Presence of Thrips.

The thrips is very readily detected in its natural haunts because it causes the leaves and stems which it attacks to turn dark-brown or black and eventually to die. The first signs of its presence are small dark-brown spots on the leaves, and in the great majority of cases the youngest leaves at the tips of the shoots are preferred.

Nature and Extent of Injury.

Both the nymphal and adult stages of this insect are injurious to Clidemia. The dark spots result from the puncturing of the plant tissues by the thrips, which sucks out the sap. The attacked leaves droop and fall off, and the whole shoot is usually so greatly weakened that it dies. Frequently all all the young shoots on a large bush are destroyed in this way, while the older leaves on the same bush remain healthy.

The thrips, by itself, rarely kills Clidemia except when it attacks young seedlings, but it greatly weakens the plants, and inhibits their growth. Plants which are badly attacked flower very little, if at all, and therefore the spread of the plant is hindered, probably to a great extent. According to Urich, a drought following thrips attacks is fatal to plants which could probably have withstood it in the absence of thrips. Infected bushes always have a stunted, unhealthy appearance and probably succumb readily to any additional adverse circumstances. We were impressed with the scarcity of fruit on Clidemia all over Trinidad and also with the complete absence of

large healthy bushes such as are to be seen in Fiji. Further, although isolated plants are common in many localities, large masses of them, covering considerable areas, are quite unknown. The thrips certainly plays an appreciable part in producing this state of things, but whether it is a sufficiently important factor to produce the same effect elsewhere we cannot say.

Life History.

The life history was studied in some detail in the laboratory. The adults are to be found on the young shoots, and rarely on any other part of the plant. The majority of them keep to the undersides of the two very young leaves at the tip of each shoot, but many are on the stems also.

The eggs are usually laid on the undersides of the youngest leaves, or on the stems, or in the angles between the petioles of the youngest leaves and the terminal buds. The undersides of the leaves and the young stems of *Clidemia hirta* are covered with a dense pubescence, and this makes the eggs, which are in contact with the surface of the leaf or stem, difficult to detect except when a leaf is held up to the light and examined with a lens. Eggs laid on the leaves are always placed near the bases of the leaves. Many eggs are laid on each shoot as a rule. The egg is pale-green and transparent when first laid, but becomes more opaque as development proceeds. In shape it is ovoid and elongate, and both ends are rounded. The duration of the egg stage is 8–9 days.

The young, first-stage nymph commences feeding immediately it emerges from the egg. On the following day a dark-brown spot appears on the leaf, marking the spot at which the nymph fed, and soon the leaf bears a number of these spots. The nymph grows rapidly and after four or five days the first moult occurs. Up till this time the nymph usually feeds on the undersides of the young leaf, regardless of where the egg was laid, but after the moult it often wanders down the stem and feeds there. Frequently the nymphs attack the petioles, causing the leaves to drop off, and this results in the formation of a soft scar on the main stem at the point of attachment of the petiole. The tissue at this spot is very soft and readily penetrated by the style of the insect, and therefore large numbers of larvæ are often seen crowding on to it. Seven days after the first moult the nymph is full-grown, and the second moult then takes place. The total duration of the nymph stage is therefore 10–12 days.

Throughout the nymphal period the head, prothorax, legs, and the two terminal abdominal segments, which are tubular, are black, while the rest of the body is bright red. This colouring makes the nymphs very conspicuous.

The second moult gives rise to the prepupal stage which is very short, and never occupies more than one day. It is terminated by the third moult after which the insect is in the pupal stage.

No further growth occurs after the second moult, and neither the pupa nor the prepupa is capable of taking nourishment. The insect is quiescent in both of these stages and usually remains more or less hidden on a shrivelled leaf or in the dense hairs at the base of a leaf throughout the non-feeding period, but the pupa and the prepupa are capable of slow movement if disturbed.

The pupa and prepupa are similar in appearance, but they differ considerably from the nymph. They too are red in colour, but of a lighter shade, and they are without the black markings which are so conspicuous on the nymph. The wing sheaths appear in the prepupa, but are short

and stumpy, and the antennæ are short and rigid, and project outwards. In the pupa the wing sheaths are long and unattached except at their bases, while the antennæ are folded back along the sides of the head.

The duration of the pupal stage is 5–6 days.

The adult remains quiescent for a day or two after it emerges from the pupal skin, and then begins feeding voraciously. It is black, opaque, and shiny. The wings are well developed in both sexes, but the insects rarely fly so long as fresh food is available. They wander actively over the plants, feeding on stems and leaves alike. Both sexes are common. Copulation was not observed, but on several occasions a female was seen with two or three males on her back. Parthenogenesis sometimes occurs. Three females, each of which had been reared by itself from the egg in a glass jar and had never come into contact with other individuals at any stage, produced fertile eggs. There is little doubt, however, that copulation is the rule. Oviposition seems to begin five or six days after emergence from the pupa. The total duration of the life-cycle, from oviposition to emergence, is about three and a half weeks (24–28 days).

The following table illustrates the life-cycles of sixteen different individuals. The records were obtained by the method described hereafter under "Laboratory Methods." The figures denote days:—

LIFE-CYCLE OF *LIOTHRIPS URICHI*.

Tube	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Egg Stage ..	8	9	..	8	8	9	9	..	8	8	8	8	8	..	9	8
Nymph I ..	10	4	..	4	4	4	5	..	4	5	5	11	5	11 or 12	4	4
Nymph II ..		6	..	7	7	7	7	..	7	7	7		6		7	7
Prepupa	1 or less	1 or less	1	1 or less	1 or less	1	1	1	1 or less	1 or less	1 or less	1 or less	1	1	..	1 or less
Pupa	5	5	5½	5	6	5	5	5	5	5	6	6	5	6	..	6
Emergence to Oviposition	..	..	5	..	..	..	..	..	5	..	..	6	5	..	..	..
Egg to Adult .	24	25	..	25	26	26	27	..	25	26	27	26	25	..	..	..

Laboratory Methods of Breeding.

Liothrips urichi was found to be very easy to breed in captivity. A number of plants of *Clidemia hirta* were potted up with thrips on them. The thrips multiplied rapidly and did much additional damage to the plants, passing three generations in the laboratory without any attention. The experiment had to be abandoned at this point, but there was every indication that the plants would die in the near future.

For a more detailed study of the life history, small healthy shoots of *Clidemia hirta*. each bearing two young leaves, were collected in the field and placed in water in glass tubes. Each tube was then covered with a glass jar. *Clidemia hirta* lasts a long time in water, and provided the water is changed every day there is no need to renew the shoots more often than every ten days. A single female thrips was placed on each shoot, and a

record kept of its activities and those of its progency, every day for seven weeks. As a result of its attacks on the shoot the leaves usually dropped off after four or five days, but the insects continued to flourish on the stem, and made no attempt to escape until the latter was dead. Thirty shoots in tubes were employed in this experiment.

Alternative Food Plants.

The careful observations of F. W. Urich and C. B. Williams, which extended over a long period of years, would almost certainly have resulted in the discovery of an alternative food plant for this insect if it existed, but none was ever found. We felt fairly certain from this that the thrips was absolutely confined to *Clidemia hirta*, but in order to satisfy ourselves on this point we made a special search on all the other common Melastomaceæ, particularly other species of Clidemia, for the thrips, but we failed to find it; and this in spite of the fact that in many localities other species of Clidemia grow very close to *Clidemia hirta*, and between two or more plants of the latter species which bear thrips. It was not possible, on account of lack of time, to experiment with the thrips on crops of economic importance, and the possibility of its attacking them is very remote, but the next best thing seemed to be to prove that it will not attack other closely allied species of *Clidemia hirta*. If close allies of *Clidemia hirta* are immune from the thrips, it is extremely unlikely to attack other plants which have no connection with *Clidemia hirta*.

The field observations on other Melastomaceæ were fairly conclusive, but a few experiments were made, in the laboratory to verify them. Young shoots of *Clidemia postulata*, *Clidemia neglecta*, and *Clidemia spicata* were arranged in tubes in the same manner as those of *Clidemia hirta*, and thrips were placed on all of them. In every case the thrips refused to feed and died in two days, although those on *Clidemia hirta* flourished in the same conditions and at the same time. Further potted plants of *Clidemia neglecta* and *Clidemia spicata* were placed among similar plants of *Clidemia hirta* already infected with thrips, but were never attacked by it. Another plant of *Clidemia hirta*, apparently healthy when potted up, was added later, and was found to be infected after a few days.

We feel fairly confident, in view of these observations, in stating that the thrips is absolutely confined to *Clidemia hirta*.

Natural Enemies.

Urich has bred a Chalcid parasite, *Tetrastichus thripophonus*, Wtrst., from the prepupæ of *Liothrips urichi*. No other natural enemies are known. We did not find this parasite, and believe it to be uncommon as a rule.

Conclusion.

Clidemia hirta is efficiently controlled in Trinidad by natural means, but the only controlling agency which could possibly be utilised in Fiji is the thrips, *Liothrips urichi*, Karny. It is impossible to say what effect this insect would have on Clidemia in bulk in Fiji, and it is quite possible that under new conditions it would prove useless. Nevertheless, provided it can be proved to attack no plants of economic importance, as seems almost certain, it is, in our opinion, worthy of a trial in Fiji.

ACTION TAKEN IN REGARD TO CONTROL OF NOXIOUS WEEDS.

By J. KERMACK, Acting Superintendent of Agriculture.

THE following steps have been taken in regard to the control of noxious weeds:—

Clidemia hirta.—On the 23rd February, 1928, the following motion was agreed to by the Legislative Council:—

> "That this Council approves in principle the expenditure from General Revenue of funds to enable detailed investigations to be made of natural enemies of *Clidemia hirta* known to occur in Trinidad."

With the approval of the Coconut Committee advantage was taken of the visit to Trinidad of Mr. Taylor, an Entomologist employed by the Committee, to have investigations made by this officer with the object of ascertaining whether any of the agencies which controlled the spread of *Clidemia hirta* in that island could be used in an endeavour to check the spread of the weed in Fiji. Mr. Taylor's report on his investigations has been received and published as Council Paper No. 14 of 1928.

Dr. Tothill considered that the Thrip referred to as likely to act as a control of *Clidemia hirta* could probably be introduced into Fiji without danger of its attacking plants of economic importance, but at the same time advised that every possible precaution be taken against hasty action as it could never be exterminated if found to be undesirable. With the approval of the Government, Dr. Tothill, therefore, wrote to the Principal of the Imperial College of Tropical Agriculture, Trinidad, asking if arrangements could be made for an entomological student at the College to conduct feeding experiments particulary on—

> coconuts, cane, bananas, pineapples, cotton, Mauritius bean, rice bean, breadfruit, sweet potatoes, taro, tobacco, yams, para grass paspalum, rice, dhal, peanuts, cocoa, rubber, tapioca, sensitive plant and maize.

A reply recently received from Colonel Evans, the Principal of the College, states that he has gone into the matter with the Acting Professor of Entomology and that, if this Government requires the experiments to be undertaken, he will ask Professor Ballou to make this investigation part of the work of a post graduate student in entomology who has already taken his degrees in entomology, as his main subject, and who is proceeding to the College for special tropical training for nine or ten months.

Sir Guy Marshall, Director of the Imperial Bureau of Entomology, has written to Dr. Tothill on this matter as follows:—

> "I have read with much interest Taylor's report on *Clidemia hirta* in Trinidad, and it would certainly seem, on the face of it, that there ought not to be much risk in introducing the *Liothrips*. At the same time, I cannot but feel that it is very improbable that it is this insect which is really keeping down the plant in Trinidad. A much more probable factor is severe competition with a number of closely allied plants. In any case, I see no objection to the very cautious plan which you have proposed, namely, that the whole matter should be fully investigated at the Imperial College of Tropical Agriculture. One of the things it seems desirable to

test is the actual effect, under control conditions, of the Thrips on the growth of the plant. Unless it can be shown experimentally that the insect can actually destroy the plant in Trinidad, there would hardly seem to be justification for introducing it into Fiji. Then, also, thorough starvation tests should be carried out with plants growing in close contact with infected *Clidemia hirta* to see whether the insect can be forced to adopt another food plant."

It is proposed to await the conclusion of the feeding experiments before taking any steps towards introducing the insect referred to into Fiji. His Excellency has, however, authorised the provision of £300 in the draft Estimates for 1929 to meet the cost of the experiments and of the introduction of the insect into Fiji if considered desirable.

Solanum torvum.—Consideration has been given to the question of the biological control of this plant. Briefly, the action taken may be set out as follows:—

(*a*) Specimens of the plant have been sent to the Royal Botanical Gardens, Kew, for a verification of the determination.
(*b*) The Kew authorities have been asked for a statement as to the original and present distribution of the plant.
(*c*) Letters have been addressed to Directors of Agriculture, Entomologists, &c., in India, Ceylon, Burma, and the Federated Malay States asking for information on the fauna of this plant.
(*d*) Sir Guy Marshall, Director of the Imperial Bureau of Entomology, has been advised of the action taken and has been asked for any advice he can give.

The Superintendent of Agriculture expects to pass through India on leave in about eighteen months' time and would be prepared, if the results of inquiries are sufficiently encouraging, to look into the matter and submit recommendations to the Government.

Lantana camara.—The spread of this plant is considerably checked by the following insects introduced by the Department:—

(*a*) *Agromyza lantanæ*, a small fly which destroys seeds.
(*b*) *Thecla echion* and *T. agra*, butterflies, the larvæ of which destroy flowers.

Agromyza lantanæ is well distributed throughout the group and the control exercised by this insect cannot be expected to increase. The two butterflies were introduced in 1922 and are now established on Vitilevu and Ovalau. They are not, however, available in sufficient numbers at the present time to permit of the collection of colonies for distribution in other areas.

Inquiries recently made by the Government Entomologist show that there is present, in Hawaii, an insect, *Teleonemia lantanæ*, which is reported to so damage the plant by the destruction of leaves as to cause a considerable reduction in seed production. As this insect is considered to be in every way suitable for introduction into Fiji, arrangements have been made to send the Government Entomologist to Honolulu to collect colonies and transport them to Fiji. The Governor has provided funds for this purpose and it is proposed that Mr. Simmonds leave for Hawaii on the 20th September.

PARASITES FROM TRINIDAD FOR THE COCONUT SCALE.

By T. H. C. Taylor, Entomologist Coconut Committee.

In Trinidad, one of the islands of the West Indies, the Coconut Scale, *Aspidiotus destructor,* is well controlled by Coccinellid beetles. Five different species of these beetles, which are popularly known as lady-birds, were found to be instrumental in the control of the scale, and in January, 1928, many hundreds of each species were shipped from Trinidad for introduction into Fiji. They travelled *via* the Panama Canal and Tahiti, and eventually reached Suva on 5th March, after five weeks at sea. Despite the many hardships to which they were unavoidably subjected en route, particularly during transhipment in Panama, all the species survived the journey satisfactorily.

The beetles devour the scale very rapidly, and the maintenance of a constant supply of scale in the form suitable for feeding the beetles was the greatest difficulty encountered during the voyage. More than 200 young coconut palms, heavily infected with scale, were shipped in Trinidad, and nearly all this scale was devoured when the ship arrived at Tahiti. No further supply of suitable scale was available in Tahiti, and when the ship was still two days' journey from Suva the last of the young palms had to be put into the breeding cages. Fortunately, these proved to be just sufficient, and three days after reaching Suva, 600 beetles were liberated on Wakaya, the remainder being kept for breeding.

The scarcity of scale in the neighbourhood of Suva at that time made it necessary to take the beetles elsewhere for the purposes of breeding and distribution. Levuka was selected as the most suitable centre for this work, and another hurried trip to Wakaya yielded sufficient varas, already infested with scale, to feed the beetles in Levuka for a week or two, until more elaborate preparations could be made. Ever since, the work has been carried on in the neighbourhood of Levuka, and will be continued there for some months.

It was apparent at the outset that the methods employed in Trinidad for breeding the beetles in large quantities would have to be modified considerably in Fiji. The chief difficulty was that the beetles, in their early stages, proved to be heavily attacked by ants, and at one time the whole shipment, except for one species, was threatened with complete destruction by them. Also, the maintenance of a constant supply of scale-infested varas has caused much trouble, and occasionally the beetles have had to be kept on short rations until a further supply could be obtained. Apart from these difficulties, which have since been eliminated, the work has progressed very satisfactorily, and the beetles are now flourishing in Fiji, in spite of the new climatic conditions to which they are exposed. The new methods evolved for breeding them, which are described hereafter, are now perfected, and are working with almost mechanical efficiency.

Identification.

The names of the five species are:—

(1) *Cryptognatha nodiceps*, Mshl.
(2) *Azya trinitatis*, Mshl.
(3) *Pentilia insidiosa*, Muls.
(4) " Spotted " sp. (unidentified).
(5) " Small " sp. (unidentified).

The colourings and markings of each species are sufficiently distinctive for identification purposes in the field. *C. nodiceps* is brownish yellow with two small black streaks in the middle of the back, side by side, and outside these a large irregular black blotch, on either side, extending almost to the hind end. This species is, however, liable to great variation, which takes the form of partial or complete union of the black markings, so that some specimens appear almost uniformly black. The surface is smooth, very shiny, and devoid of hairs.

A. trinitatis is uniformly dark-blue all over the upper surface, and is very densely covered with minute grey hairs, which make it look as if it has "bloom" on it, like a plum. It is shiny, but less so than *C. nodiceps*. The underside is brown.

P. insidiosa is extremely shiny, jet black, and hairless.

The so-called "Spotted" species is light-yellow with six prominent black spots on its back, three on either side, and a broad black streak down the middle of the back.

The "Small" species is shiny and very dark-blue, almost black, and sometimes exhibits a brownish irridescence. The head and thorax are brown.

In size, the first four species are comparable. Normal specimens are a little more than one-tenth of an inch in length. The last species, as its temporary name implies, is much smaller than the others, its average length being about one-sixteenth of an inch. All of them are hemispherical in shape.

There are two other scale-feeding Coccinellid beetles in Fiji which might be confused with the Trinidad species by those who are not well acquainted with them. The first is a species which has been known in Fiji for a long time and is often seen on scale-infested trees. It is jet black, except for the head and thorax, which are light-brown, and the surface is very shiny. It is larger and more elongated, relatively, than the Trinidad species. The second species is one which was imported from Java recently. It is smaller than any of the others, and light-brown in colour with a black patch at the anterior end of each wing-case and another at the posterior end. It is slightly hairy.

Relative Importance of the Five Species.

As far as one can judge at present the order of importance in Fiji of the five species is as follows:—

1. *C. nodiceps*.
2. "Spotted" sp.
3. *P. insidiosa*.
4. "Small" sp.
5. *A. trinitatis*.

C. nodiceps is certainly much more efficient as an enemy of the scale than any of the others. It is by far the most prolific, and its life cycle is the shortest, of them all. Therefore it multiplies more rapidly. Probably *C. nodiceps*, by itself, is capable of doing all that can be done to control the scale by natural means in Fiji, and it is doubtful whether the presence of the others will increase the control materially.

Life-Histories.

The life-histories of all the Trinidad species are very similar. It will be sufficient for the present purpose to outline the habits and life-cycle of *C. nodiceps* only.

The eggs are laid singly inside the scales. When ovipositing, the female beetle usually selects a full-grown scale, devours the contents, and then lays an egg in the space so formed. The egg is yellow, translucent, and shiny. In shape, it is ovoid and elongate, and one end is much more pointed than the other. Its length is equal to about half the diameter of a full-grown scale. The duration of the egg stage is five and a half days as a rule.

The young larva which emerges from the egg is very small and almost invisible to the naked eye. It is pale green at first, but after it has fed for a while it becomes yellow and is covered with a thin irregular deposit of white wax, with a row of delicate waxy tufts down either side. It begins to wander over the leaf as soon as it leaves the egg, feeding at intervals on the scale. After a couple of days it has increased considerably in size, and it then prepares to cast its skin. The wax is shed with the old skin, and after the moult new lateral waxy tufts are formed, and more wax, of a powdery nature, is deposited on the back. From this time onwards the waxy tufts are much thicker and more prominent, giving the larva the appearance of a mealy-bug.

The larva grows very rapidly, and it is full-grown twelve days (on the average) after it emerges from the egg. During this period it moults two more times, there being three moults altogether. It devours the scale at a great rate. The full-grown larva is of a deep yellow colour, but this colour is always obscured by the deposit of wax, so that, at a glance, the larva looks almost pure white. There is a thick dusting of wax all over the back, without any definite tufts, but down each side there is a row of eleven very long, thick, white tufts which project sideways over the leaf. Most of these tufts are as long as, or longer than, the width of the body. The second and third on either side are the longest, and the others become shorter and thinner towards the hind end. In addition to these there are two short tufts at the anterior and projecting forwards over the head, and a single, very thick, tuft at the posterior extremity which is directed backwards.

When the larva is fully fed it attaches itself firmly to the leaf or stem by its posterior segment and becomes hunched up on the back. It then casts its skin and becomes a pupa. The old larval skin is pushed back to the point of attachment but does not fall off, and the waxy tufts of the larva remain attached to it, forming an irregular bunch at the hind end of the pupa. The pupa produces no wax.

The pupa is short and thick-set. It is incapable of movement, except that it can jerk itself up and down when disturbed, as if hinged at the hind end. The colour is bright-yellow, and there is a double row of dark-brown markings down the middle of the back. It bears numerous short, very fine, hairs.

The pupal stage lasts four days, and the adult beetle then emerges, leaving the shrivelled pupal skin on the leaf.

The beetles feed very voraciously on the scale. They are capable of flying considerable distances when disturbed, or when they are in search of food, but so long as there is plenty of scale on the leaf they rarely leave it. They begin laying eggs about five days after emerging from the pupal skins. A small batch of twenty or thirty beetles will lay several hundreds of eggs on a single leaf provided the leaf bears plenty of scale, and the resulting larvæ are very readily seen at a glance. In cases like this, when the larvæ are crowded together on a single leaf, many of them invariably crawl down to the base of the leaf when full-grown and pupate in large clusters on the stem or on the fibre. These masses are very conspicuous.

Since the average figures for the duration of the egg, larval and pupal stages are 5½, 12, and 4 days respectively, the total life-cycle, from oviposition to emergence, is a little more than three weeks; and as the beetles do not begin to lay until about five days after emergence, the period that elapses between the laying of the first eggs of two successive generations is about four weeks. A new generation is therefore produced every month. This has been tested by detailed observations in the laboratory and confirmed on a large scale by observations in the field.

The egg-laying period of each individual lasts for several weeks, and the total adult life lasts for at least two months in most cases. Actually, threfore, successive generations overlap considerably.

Liberations of Colonies.

About four thousand of the Trinidad beetles have been bred and liberated in Fiji between March and July, inclusive. At first it was thought necessary to turn out as many as four or five hundred beetles in each colony, in order that they might become well established, but recent observations at Lovoni, Ovalau, indicate that 150 are ample for each colony.

At least one colony has been, or will be, liberated in each badly-infested scale area throughout Fiji. On islands like Gau and Koro, one batch has been turned out on the west coast and another on the east. The beetles will distribute themselves from these centres, but when one colony has been liberated in each of the main areas the rate of distribution will be increased artificially by collecting some of the beetles from the original locality and removing them to other parts of that area by hand.

Following is a list of the main localities in which colonies have been, or will be, liberated:—

Vanualevu.—Wairiki, Solevu, Nadi Bay, Davutu, Muanicula, Wailevu, Nagigi, Devadara, Dreketi.

Vitilevu.—Lower Rewa, Tailevu, Korolevu, Sigatoka.

Lomaiviti.—Ovalau, Wakaya, Naigani, Moturiki, Yanucalevu, Nairai, Koro, Gau.

Lau.—Moala.

Yasawa.—Naviti.

Bega.

Kadavu.

Colonies have already been liberated on Vanualevu (at Wainunu, Davutu, and near Davadara), on Ovalau (at Lovoni and Bureta), on Gau (at Garani and Vanuasou), on Koro (at Nasau and Navanga), on Wakaya (at Korolevu), and on Nairai, Moturiki, Naigani, and Yanucalailai. By the end of September (possibly sooner) at least one colony will have been liberated in all the scale areas throughout the group.

Methods of Breeding and Distribution.

At first the beetles were bred in Levuka in large cages stocked with varas which were heavily infested with scale. This method produced about five hundred beetles per generation in each cage, when it was working well, but frequently the numbers were greatly reduced through an insufficient scale supply. Unless ample scale is provided and maintained in the cages the larvæ become highly cannibalistic and reduce their numbers enormously.

The method which is now in use is giving far more satisfactory results. A patch of bananas at Cawaci, all bearing an abundance of scale, was selected, and a large number of cheese-cloth bags, each 1½ yards long, were prepared. Each bag just fits over a banana leaf, and by tying the bag round the leaf steam at one end and closing up the other end, the leaf can be enclosed completely. Ants and other undesirables are excluded by putting a band of tanglefoot (a sticky substance which is weather-proof) round the base of the leaf stem. Beetles are put into the bag and are left there long enough to produce as many larvæ as can feed up on the scale available on the leaf.

Experiments have shown that the most convenient number of beetles to have in each bag is thirty and that a week is the most suitable period to leave them in the bag. If on 1st July, for instance, thirty beetles were put into a certain bag, they would be allowed to lay eggs in the scale, and feed on it, for a week. Then on 8th July, they would be removed, the bag closed up again, and the beetles put into another bag on a new leaf. On 15th July, they are transferred again, and so on, week after week, until they have laid all their eggs. The bag which was put on the leaf on 1st July will be full of larvæ of all ages on 15th July, and on or about 22nd July the first beetle will emerge.

The total number of beetles produced in each bag is at least 200, and often more than 300. In this way large numbers are produced very easily, and the method has the additional advantage of providing valuable data concerning the rate of multiplication, the rate of mortality, the egg capacity, and so on, under natural conditions.

Prospects of Success.

It is impossible yet definitely to predict what effect these insects will have on the scale in Fiji, but it can certainly be said that the prospects are hopeful. In all these localities which have been revisited some time after the original colonies were liberated, the beetles have been found to be very well established, to have multiplied greatly, and to have spread to some extent. Rapid results over wide areas, however, cannot be expected, and it will probably be a matter of several years before the full effect of the beetles can be estimated.

This account has been written primarily to give planters a general idea of what is being done and to enable those who wish to do so, to recognise the various species and to follow the activities of the beetles on their own estates. After the beetles have been liberated on estates, those in charge of the work will be glad to receive occasional reports on the rate of spread and on other matters connected with the scale which may arise.

INTRODUCTION.

By J. D. Tothill, Superintendent of Agriculture.

The time is not far distant when Coconut Planters in this Colony will have to consider the question of replanting their estates and when that time comes it will be desirable to have ready a supply of seed of improved type.

There are individual coconut trees here and there that produce more copra than their neighbours because it is inherent in them so to do. If all the trees in a plantation were of the same stock as the few good ones the yield of copra would be greater than at present.

It has not been possible anywhere so far to collect the good trees into a plantation because most types of coconuts are dependent on cross pollination. Seed nuts collected from these isolated good trees have consequently produced disappointing trees because they are the result of female flowers on the good trees being crossed with the pollen of the ordinary trees near by.

If some artificial way could be found of carrying pollen from a good tree to the female flower of another good tree then the resulting nuts would have an extra good parent on both sides of the house and could reasonably be expected to produce trees as good as the parents. As the difficulties did not appear to be insuperable Mr. Maréchal, who in addition to technical training has had practical experience in plant breeding at the well known Javanese Experimental Station at Buitenzorg, was attached to the Coconut Committee Staff to explore the possibilities.

In the following article he shows how he has been able to keep pollen in an active condition for 16 days and explains how as a result of this he has been able to cross selected parent trees successfully. Three small nurseries of what are likely to be commercially pure strains of improved coconuts are now being established, and if the work is pursued diligently for a few years there appears to be no reason why a better seed supply cannot be made available to the community. Such seed will not be available in a few years because it takes up to ten years for trees to come into proper bearing. It can probably be made available by the time replanting has to be done on an extensive scale.

On the financial side there appears to be a reasonable expectation of increasing the output of copra from the Colony. By seed selection of the type indicated it might be increased by one-fifth and perhaps by considerably more. On the basis of one-fifth this would represent an increased value of exports of £100,000 per annum on the present output of approximately 27,000 tons.

We believe that Mr. Maréchal's preliminary observations and experiments will prove interesting and instructive not only to technical workers and plant-breeders but to planters generally, and he has therefore prepared a somewhat detailed account of his investigations for this issue.

OBSERVATIONS AND PRELIMINARY EXPERIMENTS ON THE COCONUT PALM WITH A VIEW TO DEVELOPING IMPROVED SEED-NUTS FOR FIJI.

By H. Marechal, Agronomist, Coconut Committee.

When the coconut palm begins to bloom, which depending on the varieties and on climate, treatment, soil and other external influences, may be at different ages, it is the rule that one spathe appears in the axis of each leaf.

This spathe bends over either to the right or the left of the subtending leaf in a direction which is opposite to that of the spiral formed by the unfolding leaves.

Every year from 12 to 13 leaves are formed, depending on the variety and probably also on climate, so that one leaf and consequently one spathe corresponds roughly with one month in development. Ordinarily the spathe splits open over the full length commencing about 6 inches under the apex and on the side which is turned towards the subtending leaf. Sometimes it opens on the other side in a less complete way which results in part of the flowering branch or spadix remaining enclosed in the sheath or spathe, so that the spadix cannot develop properly. If, in such a case, spathe-borers are busy in the spathe many flowers will be damaged and become a total loss.

When the spathe is fully open, the spadix appears. It consists of a main stalk with numerous side branches each of which carries a large number of small buds. The branchlets which vary greatly in length for the different varieties, are placed in spirals on the main stalk. A careful study will show that there are four of these spirals.

If one start at the lower end and follows the first, second, third, and so on, of the branchlets it will be seen that there is a certain regularity in angle between 1 and 5, 5 and 9, 9 and 13, 13 and 17, &c. The same appears again when following 2, 6, 10, 14, &c., 3, 7, 11, 15, and 4, 8, 12, 16, 20, &c. Each of these series forms one spiral. The rounder the main stalk and the less flattened the whole spathe, the nearer these angles come to equal each other.

Some of the buds on the branchlets are larger than others, and appear as small spherical bodies more resembling small nuts than flowers. These however, are the buds of the female flowers, while the small ones are the male flower buds. The female flowers are usually placed on the lower ends of the branchlets alone, sometimes in couples or threes up to fives. Now if two female flowers occur on a branchlet, say, No. 3, it will often be seen that also 7, 11, and 15, &c., or some of these have two female flowers.

The diagram of a spathe which was called 8 of a Malayan dwarf coconut tree B8 has the following aspect and may serve as a good example. The o's represent the number of female flowers on each branchlet of the spadix:—

Diagram of Spathe 8, Tree B8:—

```
ooooooooooooooooooooooooooooo
                oo  o  o  oo  oo  o  o oo
                o   o  o      o        o oo
                o   o  o                 oo
                                         oo
                                         o
First Spiral .. .. .. o  o  o  o  o  o  o  o
                                  o
Second Spiral .. .. .. o  o  o  o  o  o  o
Third Spiral  .. .. .. o  o  o  o  o  o  o
                       o  o  o  o
                       o  o  o
                       o  o  o
Fourth Spiral .. .. .. o  o  o  o  o  o  o
                       o           o  o  o  o
                                   o        o
```

The first spiral has single female flowers except on branch 21, the second spiral has only single female flowers. The third and fourth however show

a strong tendency to two or more femle flowers on each branchlet. The 13 at the end of the diagram were all situated on the end of the stalk.

It was noticed among the Malayan dwarfs that the spathes which open in the months from November till March tend to carry a larger number of female flowers than those opening during the other part of the year. It was also noticed that when a tree is coming into bearing, the first spadices to appear have, as a rule, only one or two spirals developed, while gradually after 8 to 10 months all four are carrying female flowers. Soon after that there may be a spiral developing doubles and so on. At the same time the number of branchlets increases till the maximum for that tree has been reached. This number is for the Malayan dwarf 30 or 31 including the end of the main stalk. For different types of Niu lekas these numbers vary from 50 to 70 and for Rotuma coconuts imported into Taveuni it was found to be 42.

The number of female flowers per branchlet varies for Malayan dwarf from 1 to 5, while observations on Niu lekas proved that more than 5 female flowers may be found on one branchlet. This is probably also the case with the common coconut in Fiji. The Malayan dwarfs on which these observations were made only started to bear a year and half ago and it is possible that the whole aspect of the spadices will change with the age of the trees.

It was found that trees producing female flowers regularly on most of the branches and with a tendency to form doubles and trebles, could be considered the healthiest and actually produced pollen more abundantly and of a higher vitality.

The branchlets which carry no female flowers are, as a rule, shorter than the others.

The Male Flower.

The male flower which is sessile consists of a perianth, six stamens, and a rudimentary pistil. The perianth consists of 6 floral leaves placed in two whorls of three each of which the inner whorl has leaves at least three times as long as the alternating other three. These leaves are more or less pointed and vary in colour from pale-yellow and green to orange. The six stamens are placed inside the inner whorl of perianth leaves and produce a yellow dry powder which is called pollen. In the centre of the male flowers a rudimentary pistil can be seen bearing three triangular points bent slightly outwards. Alternating with the points are three nectar glands, exuding an agreeably scented honey, which attracts all sorts of insects. The pollen is shed as soon as the flowers open. It is then dry and easily spread by the least bit of wind.

The male flowers are crowded, with more or less space between them, from the tops of the branchlets down as far as the female flowers. Closed, they are about half an inch long, pointed and triangular on transverse section. Their shape is sometimes very irregular especially when the number is very large, so that the flowers have been closely and tightly packed.

One or two male flowers may sometimes be found alongside the females, sometimes none at all. This has to be watched closely when a spathe is to be emasculated for pollination experiments, lest these few flowers, so easily overlooked, cause selfpollination.

The male flowers begin opening at the ends of the utmost top branchlets, subsequently those of some of the lower top and middle branches burst open. When the middle branchlets are fully open 40 to 60 per cent. of

the flowers on the top branches have ceased shedding pollen and have dropped, while at the same time flowers of the lower branches commence to open.

The Female Flower.

The female flowers are sessile and situated on the lower part of the branchlet. When the spathe opens they are from ½ to ¾ inches in diameter and equally long, of a creamy colour and totally enclosed in the perianth leaves. Once light enters the spathe they grow rapidly but it still takes from 8 to 30 days to grow to full size, from ¾ to 1¼ inch in diameter. Then the perianth is of a green to reddish hue according to variety. The perianth leaves, of which there are six as with the male flowers, are also here placed in two whorls of three. The larger three are kidney shaped and at first enclose the gynæcium or pistil entirely while the smaller ones which are very thick and strong form a strong base for the female flower and later for the small coconut. Gradually the larger perianth leaves part and expose a pointed triangular surface of the gynæcium of which the top splits into three points. These points slowly bend backward and turn a rib with a rough surface upwards. The roughness of these ribs is caused by protruding long shaped cells of unequal length, which form the stigma of the pistil. Each of these three ribs corresponds with one ovular cavity in the base. Each cavity contains one ovum, of which as a rule only one develops into a seed, the later coconut. However, sometimes two or even all three grow into seeds and this is the cause of coconut trees with two or three stems growing out of one planted nut.

Alternating with the three points of the stigma, in the space surrounding these, three dark coloured slits or pores can be seen, the nectar pores, which exude large drops of honey. The production of nectar begins when the top of the pistil splits and the ribs of the stigma become exposed and lasts until the stigma starts withering.

Another fluid is secreted through numerous pores both in region where the nectar pores are and also below this. This fluid is sipped away by insects like the nectar but leaves small white crystals, probably of calcium oxalate, which gives the top part of the pistil a powdered appearance.

The Male Phase.

Very few data are available concerning the male phase of the Malayan dwarfs. With this variety the male phase begins as soon as the spathe opens and finishes near the end of the female phase. But nearly all the trees on which observations were made were used for pollination purposes and consequently had to be emasculated. The male phase of Malayan dwarfs was never observed to end before the female phase began, as it does in Niu lekas and Rotumas. In those varieties the male phase is always finished from 1 to 5 days before the female phase commences.

The Female Phase.

Before duration of the female phase can be determined it must be known exactly when the female flower is receptive. Receptivity begins when the three points of the stigma are well bent back and a fluid exuding from between the protruding surface cells moistens the narrow ribs. The stigmas are then white. Nectar flowing from the slit-shaped pores is produced several hours before receptivity begins and continues to flow during the whole receptivity period and some time after. The nectar spreads a

rather agreeable scent which attracts all sorts of insects. Several drops of this nectar collected in a small phial kept the scent for several days even after the fluid started fermenting. This nectar contains sugars and also some other constituent which is deadly for pollen submerged in it. Sugar solutions do not kill pollen but cause it to germinate.

The stigmas remain receptive from twenty-four hours to two days depending on the variety of coconut and it appears to me that they remain longer receptive when not pollinated, that is, if bagged so that no insects can reach them.

The following data on the female phase were collected on Niu lekas:—

Tree.	No. of Spathe.	No. of days between opening of Spathe and first female receptive.	Duration of female phase in days.	Total.
A3	9	27	7	34
A4	10	..	2	..
	9	..	..	27
	8	28	2	30
Bo	11	16	5	21
	10	16	16	32
	9	9	20	29
B2	8	24	4	28
Co	10	24	2	26
	11	21	7	28
C5	9	..	12	..
	8	30	2	32
D1	11	30	3	33
	10	31	8	39
	9	27	..	..
D3	9	30	7	37
	8	31	2	33
D4	10	..	4	..
	9	29	3	32
D8	9	26	3	29
	..	21	3	24
D10	10	..	8	..
	9	32	4	36
E2	8	28	5	33
E3	9	..	5	..
F6	10	..	3	..
	9	32	2	34
	8	28	4	32

It will be seen that the female phase lasts from 2–20 days, mostly, however, from 2–8 days, and the period between opening of the spathe and the end

of female phase is from 21 to 39 days, which means that in many cases, here in 13 out of 21, the spathes come open before the female phase of the preceding one is ended. But as the male flowers never open until 7 to 10 days after opening of the spathes there is no chance for self-pollination.

From 58 spathes of Malayan dwarfs on which experiments were made and which have been closely watched, the opening dates are known and also the dates on which the first female flower became receptive:—

Tree.	No. of Spathe.	No. of days between opening of Spathe and first female receptive.	Duration of female phase in days.
A6	10	12	7
	9	9	13
	8	11	15
	7	12	10
B3	10	15	9
	9	15	12
	8	17	..
B6	11	10	9
	9	13	10
	8	16	7
B7	10	5	8
	9	12	10
	7	12	8
B8	11	14	12
	10	14	10
	9	15	10
D2	11	15	6
	10	20	8
	8	18	5
D5	10	17	9
	8	10	12
D7	10	5	17
	9	13	14
	8	12	9
E3	10	7	15
	9	16	6
	8	15	9
E5	10	15	8
E6	10	15	11
E7	10	10	11
	9	12	13
	8	8	9
F2	10	8	16
	9	20	4
	8	11	13

Tree.	No. of Spathe.	No. of days between opening of Spathe and first female receptive.	Duration of female phase in days.
F3	10	18	6
	9	19	..
	8	14	10
F6	8	9	15
F7	11	7	..
	10	16	8
G4	11	12	4
	10	11	10
G5	10	16	11
	9	11	6
	8	17	7
	7	16	..
G6	9	6	11
	8	23	3
	7	10	..
G7	11	9	..
	10	19	6
	9	16	..
	8	16	5
H6	10	9	14
	9	19	4
	8	11	13

The trees B3, B8 and G5 show some regularity in the duration of the period between the opening of the spathe and the first female flower becoming receptive. Only B8 has regularity in the duration of the female phase. It can be seen that the first female flower becomes receptive within 5 to 23 days (mostly within 10 to 16 days) from the opening of spathe while the female phase lasts from 3 to 17 days (mostly from 5 to 13 days).

As a rule only one or two female flowers on the lower branchlets of the stalk come open first, then after a few days some more become receptive and these may be found on any part of the spadix while the female phase ends with a few late-comers usually much smaller flowers at the top and also at the lower end of the stalk.

The Pollen.

Pollen when fresh is a dry pale-yellow powder which is produced in the anthers of the stamens. A pollen grain of the coconut is globular without any points, irregularities or markings and with a smooth surface. It consists of an outer cuticularised membrance called extine, and a very thin inner cellulose membrane, the intine. This intine contains a fluid, plasma, in which are submerged granules and two larger bodies, nuclei, one of which is the male reproductive cell, or generative cell, the other being termed vegetative cell of the pollen grain.

When submerged in a weak cane sugar solution a pollen grain absorbs water and begins to germinate through a small opening. In the extine, the germinating pore, a small tube is emitted, which is a protrusion of the intine. In this the granules may be seen moving as small currents.

In a suitable solution the pollen tube may grow out to 30 or 40 times the diameter of the pollen grain. This can be easily observed by letting pollen germinate in a so called hanging drop. If no glass rings are available for these hanging drops, cardboard rings may be suitably used and if the tests have to last from 6 to 24 hours or longer it will be well to moisten the paper rings with water by means of glass capillaries and by placing the preparations in a so-called moist chamber.

Collecting Pollen.

Pollen can be collected at once from the tree by tapping the spadix or the branchlets separately, holding a black paper underneath, but there must be no wind. This system, however, is very unsatisfactory, because one has to carry—besides black paper, brushes and glass tubes—also a dessicator into the field. I found it more satisfactory to cut several of the middle branchlets of a spadix of which the top branches have ceased blossoming, close to the main stalk, bundle them together, and bring them home in a strong brown-paper bag.

It will be well to collect the flowers just before leaving the field to prevent them from drying out too much. The best time for cutting is apparently in the early morning after the dew has dried up about 8 a.m. The flowers must be placed in fresh water as soon as possible, after cutting the stem afresh with a sharp knife or secateurs. After removing all the dead and empty flowers, the insect eaten ones, the borer dirt, and eventually earwigs, one or two branches are placed in each of six or seven glass tubes about one inch in diameter and four inches long. The glass tubes are in their turn placed in a tube stand in a slanting position, so that the branches do not stand upright, but nearly horizontal. The tube stand is then placed on a black paper in a flat box, for which a kerosene box is rather useful, and covered with a pane of glass or a piece of perforated zinc, in order to keep flying insects away.

If the branches are collected in the early morning many of the flowers will come open within a few hours and during the warm part of the day, so that the pollen may be collected, the same day in the afternoon. If, however, the branches were cut during the afternoon the flowers will not come open that same day, but can stand over till the next day and the pollen may be collected about noon. There is very little or no difference in vitality of pollen collected one way or the other. If no black paper is available, smooth drawing paper can be twice coated with good India ink and dried well. If kept dry and free from moulds such paper can be used a long time.

When the pollen is to be collected the branchlets in the box are gently tapped causing the pollen still in the anthers to fall on the black paper. The tube stand with the flowers is removed and the pollen gathered on the paper with a very soft camel hair brush, if possible a flat one. With a fine soft brush, No. 1 and 2, the pollen is subsequently picked up and placed in small glass tubes, which in their turn are placed in a suitable dessicator. It is convenient to divide the quantity of pollen among many tubes, especially if it is to be used on different days. These tubes are loosely closed with a plug of cotton wool.

Preservation of Pollen.

The problem next to be considered is how to keep pollen in a highly viable condition and for what length of time. Literature on this subject is scarce. H. C. Sampson in his book "The Coconut Palm," writes that pollen can be kept for several days in hermetically sealed tubes without losing its vitality. C. X. Furtado [in the "Gardens Bulletin," Straits Settlement of 7th November, 1924, page 267] says, that after 7 days only 3 per cent. of the coconut pollen germinated in a 20 per cent. cane sugar solution. Aldaba [in the "Phillipine Agriculturist" of December, 1921, page 207] claims that pollen grains of coconut germinate in a 5 to 30 per cent. cane sugar solution and remain viable from 2 to 9 days. These last two authors do not mention how they preserved their pollen.

These experiments were repeated by me as far as possible and the results were very unsatisfactory. Comparative tests were made in hanging drops with fresh pollen from a tree growing at the Experimental Farm at Nasinu in the following solutions: saccharose 20, 25, and 30 per cent.; glucose 10 and 15 per cent.; bees honey and nectar gathered from female flowers.

See following Table I.

I.—Pollen from Tree I, Nasinu Experimental Farm.

Cut, 12th May, 1926. Pollen shed and collected, 10.30 a.m., 13th May, 1926.

Date of Test.	Tree.	Germination Fluid.	Germination—Test started at 10.30 a.m.
13 May, 1926	I	Sacchrose, 20 per cent. ..	4 p.m .a few have germinated, tubes formed ½–2 × diameter, they did mostly burst.
	II	Sacchrose, 25 per cent. ..	4 p.m. 60 per cent. germinated, tubes 3 × diameter, many burst.
	III	Sacchrose, 30 per cent. ..	4 p.m. few tubes are formed, 70 per cent. burst.
	IV	Glucose, 10 per cent.	4 p.m. 7 per cent. formed, tubes 1 × diameter, all burst.
	V	Glucose, 15 per cent.	4 p.m. 40 per cent. germinated, tubes 3 × diameter, nearly all burst.
	VI	Nectar from female flower, Tree IV, Nasinu.	4 p.m. no change. May 14th, 9. am. no germination.
	VII	Bees honey	May 14th, 9 a.m. no germination.

Twenty-five per cent. saccharose showed 60 per cent. germination after 6 hours. Fifteen per cent. glucose showing 40 per cent. germination after the same period of time, and both the honeys none at all. This proves that the nectar secreted by the female flowers is certainly a different fluid to that which moistens the stigmas and in which pollen does germinate. As the nectar is sipped away as a rule by insects: bees, hornets, ants, &c., and is probably only meant to attract these insects which in turn, assist in pollination.

The next series of tests were made with pollen kept:—

A.—In a dessicator with $CaCl_2$ in light.

B.—In a dessicator with $CaCl_2$ in dark.

C.—In a hermetically sealed tube (rubber stopper) in light.

D.—In a hermetically sealed tube (rubber stopper) in dark.

E.—In glass tubes with cork stoppers in light.

F.—In glass tubes with cork stoppers in dark.

G.—In dessicator with 50 per cent. sulphuric acid in light.

For germination media 25 per cent. saccharose and 15 per cent. glucose were used. After three days, the first tests were made. The results are shown in the following Table II.

II.—Preservation Test with Pollen from Tree I, Nasinu Experimental Farm.

Cut, 12th May, 1926, 2.30 p.m. Shed and collected, 13th May, 1926, 9 a.m.

	Germination fluids.		15/5/26.		17/5/26.		18/5/26.		19/5/26.	
	25 per cent. saccharose.	15 per cent. glucose.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
			%		%		%		%	
A1	S	..	80	23	40	3	nil	22½	nil	21½
AII	..	G	nil	23	..	..	..	..	..	..
B1	S	..	10	23	10	5	20	22½	2	21½
BII	..	G	25	23	..	..	..	..	..	..
C1	S	..	Sporadic	3⅛	50	5	30	22½	nil	21½
CII	..	G	30	3⅛	..	..	..	..	..	..
D1	S	..	80	23	80	5	20	22½	nil	21½
DII	..	G	Sporadic	3⅛	..	..	..	..	..	..
E1	S	..	80	23	80	22	5	22½	nil	21½
EII	..	G	10	23	..	..	..	..	..	..
F1	S	..	25	3⅛	5	5	..	..	..	..
FII	..	G	10	23	..	..	..	..	..	..
G1	S	..	80	2⅜	10	22	30	22½	6	21½
GII	..	G	nil	23	..	..	..	..	..	..

The results showed that the 15 per cent. glucose had never more than 30 per cent. germination. In consequence, this fluid as a germination medium was abandoned in further tests. The 25 per cent. saccharose test showed 80 per cent. germination in cases of D and E after five days, and 30 per cent. in cases of C and G after six days. It was found also that pollen which was preserved in a dessicator with 50 per cent. sulphuric acid maintained a higher germination percentage, than the pollen which was kept in a hermetically sealed tube.

Here an explanation is necessary, as it is evident that pollen, in order to keep a high vitality for a longer period than under ordinary conditions, required stability of atmospheric conditions. Now if pollen is gathered on different days with a different humidity and atmospheric pressure, it is evident that the air closed up in hermetically sealed tubes will be just as different. These conditions very likely are not optimum for coconut pollen. To me this suggests that a dessicator with 50 per cent. H2So4, which has not a strong dessicating influence, is able to offer a permanent homogenic condition of atmosphere. A quick opening and closing of this dessicator has little effect on the humidity.

So far, pollen gathered from palms growing at Nasinu, or Tokalau, was used for these germination tests, these trees all being in a very poor condition. The average yield never exceeded 12 nuts a year. The reasons for this poor yield were lack of cultivation, ravages committed by the *Levuana* moth in past years, and ravages by other moths which attack the flowers, mentioned elsewhere. The palms do not produce one spathe a month regularly, and these, when produced, are subjected to the attacks by the Spathe Boring Moth, *Acritocera negligens*, and another flower destroying moth, *Tirathaba trichogramma*, and in the course of these attacks, both male and female flowers suffer considerably.

In order to find out whether the bad conditions that prevail have any effect on the vitality of the pollen that they produce, a test was made with pollen taken from a very healthy tree, one which had escaped from the activities of these insect pests, and which had an average yearly yield of, say, 80 nuts, and is growing in the centre of Suva, in a private garden. The results from the test made on this palm will be shown below under tree labelled S.

In the meanwhile further tests were carried out with pollen taken from trees growing at Nasinu—this pollen was kept in dessicators:—

A.—With $CaCl_2$ in light.

B.—With $CaCl_2$ in dark.

C.—With Ca O in light.

D.—With Ca O in dark.

E.—With 50 per cent. H_2SO_4 in light.

G.—With 50 per cent. H_2SO_4 in dark.

III.—Germination Test with Pollen from Trees IV and V at Nasinu Experimental Farm.

In 25 per cent. saccharose solution (not sterlised). Cut, 11th June, 1926. Shed and collected, 12th June, 1926, 2 p.m.

	16/6/26.		17/6/26.		18/6/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
	%		%		%	
A IV	nil	22	..	..	..	..
A IV	nil	22	..	..	..	..
A V	nil	22	..	..	..	..
A V	nil	22	..	..	..	..
B IV	nil	22	..	..	..	..
B IV	5	6½	..	..	..	..
B V	nil	22	..	..	..	..
B V	1	6½	..	..	..	..
C IV	nil	22	..	..	..	..
C IV	nil	22	..	..	..	..
C V	nil	22	..	..	..	..
C V	nil	22	..	..	..	..
D IV	nil	22	..	..	..	..
D IV	nil	22	..	..	..	..
D V	nil	22	..	..	..	..
D V	nil	22	..	..	..	..
E IV	80	22	13	22	nil	25
E IV	80	22	20	22	nil	25
E V	90	22	3	22	nil	25
E V	90	22	3	22	nil	25
G IV	nil	22	..	..	..	..
G IV	1	22	..	..	..	..
G V	nil	22	..	..	..	..
G V	nil	22	..	..	..	..

The table shows that after four days keeping B gave in one instance a germination of 5 per cent. while A, C, and D did not germinate. E gave 80 per cent. germination for one tree and 90 per cent. for the other. Further this test demonstrated the fact that *coconut pollen requires light to keep alive*, and full daylight at that.

Nearly all former tests were made in 25 per cent. cane sugar solution, which was occasionally renewed, but not for all tests. As these solutions were not sterilised, they developed bacteria, or moulds which was very often obstructive to proper observation through the microscope. Therefore all further tests were made with a solution of 25 *per cent. saccharose and* 1½ *per cent. gelatine*, as recommended in Botanical Handbooks. This solu-

tion was *sterilised* and kept in small containers, holding only 1c.c.m. so that only a small quantity need be in use at the same time. Blank tests showed that if properly treated, the solution in each container could be used for three days without developing moulds. I use every quantity only two days to be certain.

The next test was made with pollen from the above mentioned good tree, S, and from two other trees from Nasinu which were comparatively poor trees, and which were numbered N I and N III, as shown in Table IV:—

IV.—Preservation Test with Pollen from Tree S and Two Trees, Nasinu Experimental Farm, I and III.

All pollen kept in daylight.
Germination fluid was 25 per cent. saccharose plus 1½ per cent. gelatine (sterilised).
S 19/6 was cut 18/6 and collected 19/6, kept in dessicator 50 per cent. H_2SO_4
S 19/6 XX is control test.
S 20/6 was cut 18/6 and collected 20/6, kept in dessicator 50 per cent. H_2SO_4
S 20/6 XX is control test.
NI 20/6 was cut 19/6 and collected 20/6, kept in dessicator 50 per cent. H_2SO_4
NI 20/6 XX is control test.
NIII 20/6 was cut 19/6 and collected 20/6, kept in dessicator 50 per cent. H_2SO_4
NIII 20/6 XX is control test.

	22/6/26.		23/6/26.		24/6/26.		25/6/26.		26/6/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
	%		%		%		%		%	
S 19/6	40	21	85	23	80	21	70	23	85	3½
S 19/6	70	21	85	23	80	21	75	23	75	3½
S 20/6	1?	21	80	23	75	21	*	23	..	..
S 20/6	85	21	75	23	80	21	*	..	..	..
S 19/6 XX.....	..	..	..	..	3	4	1	6	nil	24
S 19/6 XX.....	..	..	..	..	5	21	1	6	nil	24
S 20/6 XX.....	75	21	25	23	5	21	8	6	2	3½
S 20/6 XX.....	80	21	24	23	8	21	6	6	3	3½
NI 20/6	75	21	55	23	45	21	35	23	17	5½
NI 20/6	70	21	65	23	25	21	35	23	15	5½
NIII 20/6	5	21	22	23	35	21	35	23	28	24
NIII 20/6	30	21	18	23	53	21	60	23	25	24
NI 20/6 XX ...	..	..	..	..	..	..	25	23	21	24
NI 20/6 XX ...	..	..	..	..	..	..	25	23	24	24
NIII 20/6 XX .	..	..	..	..	..	..	33	23	23	24
NIII 20/6 XX .	..	..	..	..	..	..	30	23	26	24

* Pollen supply exhausted.

Continued :—

	27/6/26.		28/6/26.		29/6/26.		30/6/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
	%		%		%		%	
S 19/6	80	23	80	8½	55	23	25	23
S 19/6	78	23	80	8½	50	23	35	23
S 20/6	..	..	..	..	..	..	..	..
S 20/6	..	..	..	..	..	..	..	..
S 19/6 XX.....	..	..	..	..	..	..	..	..
S 19/6 XX.....	..	..	..	..	..	..	..	..
S 20/6 XX.....	..	..	..	..	..	..	..	..
S 20/6 XX.....	..	..	..	..	..	..	..	..
NI 20/6	*	..	..	..	..	..	..	..
NI 20/6	*	..	..	..	..	..	..	..
NIII 20/6	*	..	..	..	..	..	..	..
NIII 20/6	*	..	..	..	..	..	..	..
NI 20/6 XX ...	15	23	3	6½	..	..	..	..
NI 20/6 XX ...	22	23	5	6½	..	..	..	..
NIII 26/6 XX .	nil	23	..	..	..	..	..	..
NIII 20/6 XX .	nil	23	..	..	..	..	..	..

* Pollen supply exhausted.

The results were that pollen from tree S, had a germination of 80 per cent. after 10 days, while a control test kept under ordinary conditions in a glass tube closed with cotton wool with the same pollen had not even 50 per cent. five days before. The pollen from both of the Nasinu trees had a much lower germination five days earlier, which induces me to believe that pollen drawn from trees in good condition have a higher vitality which is maintained for a longer period, than pollen from trees in a poor condition. Furthermore, pollen from a tree of high vitality is quicker in germinating and forms much longer pollen tubes, while pollen from poorer trees takes hours longer in germinating, forms tubes only several times the diameter of the pollen, and shows a weaker intine, which is shown by a high percentage of pollen bursting before, or while germinating.

I need hardly add, in view of the above, that a careful selection must be made, and only pollen from trees in a first class condition should be used to obtain the maximum results. It is clear also, that no pollen should be used for pollination, which has not been thoroughly tested.

The question still remained, whether 50 per cent. was the most favourable concentration for the sulphuric acid in the dessicator and a test was made with the pollen taken from the poor trees of Nasinu, and were kept in dessicators with 40, 50, and 60 per cent. H 2S O4. This showed that the neutral test had a germination of 80 per cent. after 6 days. Thereafter, this went rapidly down, and was practically nil after 8 days. The same pollen kept in a hermetically sealed tube, showed 70 per cent. gemination after 8 days, and only 8 per cent. on the ninth day, while that from the

50 per cent. H2S O4 dessicator showed 12½ per cent. after 8 days, and only 1 per cent. on the ninth day. However, the pollen from the 40 per cent. H2S O4 dessicator had fully 80 per cent. germination on the eighth day, and still showed a 20 per cent. germination on the tenth day.

V.—Preservation Test with Pollen from Tree VII, Spathe 7, on Nasinu Experimental Farm.

The spathe was cut whole and placed in water, 25/6/26, 3 p.m.
Pollen shed and collected, 26/6, 9 a.m.
NVII 26/6 XX under ordinary conditions.
NVII 26/6 XX in tube with rubber cork hermetically sealed.
NVII 26/6 XX in dessicators with 60, 50, and 40 per cent. H_2SO_4

	26/6/26.		27/6/26.		30/6/26.		1/7/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
	%		%		%		%	
N VII 26/6, 40% dessicator	..	..	..	..	90	22	82	4½
Do. do.	..	..	..	..	90	22	85	5
N VII 26/6, 50% dessicator	..	..	..	..	..	..	..	..
Do. do.	..	..	..	..	..	..	..	..
N VII 26/6, 60% dessicator	..	..	..	..	10	22	6	22
Do. do.	..	..	..	..	12	22	8	22
N VII 26/6 XX	95	6	90	6	80	22	80	8
Do.	95	6	90	6	70	22	82	10
N VII 26/6 rubber stopper	..	..	..	..	..	..	..	..
Do. do.	..	..	..	..	..	..	..	..

Continued :—

	2/7/26.		3/7/26.		5/7/26.		6/7/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
	%		%		%		%	
N VII 26/6, 40% dessicator	80	22	80	22	25	6	20	22
Do. do.	80	22	80	22	25	6	18	22
N VII 26/6, 50% dessicator	..	..	15	6	2	6	..	..
Do. do.	..	..	10	6	1	6	..	..
N VII 26/6, 60% dessicator	6	22	5	22	1	22	..	..
Do. do.	4	22	3	22	1	22	..	..
N VII 26/6 XX	55	22	45	6	..	22	..	..
Do.	45	22	40	6	1	22	..	..
N VII 26/6 rubber stopper	..	..	75	8	10	22	..	22
Do. do.	..	..	65	8	8	22	..	22

The natural conclusion to be drawn from this test is that 40 per cent. sulphuric acid had a more favourable influence on this particular pollen than 50 per cent. sulphuric acid. Not being satisfied with the results of preserving pollen in a dessicator with 40 per cent. sulphuric acid I made further tests to find out whether a lower percentage would prove better. Thirty per cent. proved to be slightly more satisfactory, but 20 per cent. was entirely unsatisfactory. Sometimes however 40 per cent. was better than 30 per cent.

These facts suggest that 30 and 40 per cent. are both situated not far from the top of a curve, while the optimum per cent. is somewhere between 30 and 40. (See Table VI.)

VI.—Comparative Tests with Pollen kept in Dessicators respectively, holding 40, 30, and 20 per cent. H_2SO_4 (D5, 2/10/26).

The Pollen used was from Malayan Dwarf.

Date of tests.	Duration of test in hours.	Age of pollen used.	Germination in per cent. of Pollen from the Dessicator with H_2SO_4			Lengths of Pollen Tubes.			Temperatures.			
			40%	30%	20%				7 p.m.	Noon.	5 p.m.	Max.
7/10	A 7	5	95	90	50	10–12	10–12	10–12	77	83	77	85
	B 7	5	90	90	40	10–12	10–12	10–12	..	..	..	..
9/10	A 8½	7	45	85	42	8–12	8–12	6–8	75	83	79	85
	B 8½	7	50	70	30	8–12	6–10	4–6	..	..	..	..
10/10	A 10½	8	80	75	5	10–12	10–14	3–5	75	83½	76	86
	B 10½	8	85	85	30	10–12	12–16	10–15	..	..	..	..
11/10	A 8	9	85	85	2	4–10	6–10	5–12	73½	82	80	86½
	B 8	9	85	75	1	4–10	6–10	2–4	..	..	..	..
12/10	A 8½	10	75	80	..	4–10	12–16	..	72	81	76½	86
	B 8½	10	70	80	..	6–12	12–16	..	..	..	..	..
13/10	A	*	..	..	..	..	..	..	..	..	..	..
	B	*	..	..	..	..	..	..	..	..	..	..

* Pollen exhausted.

Further tests were made with germination solutions, containing besides 25 per cent. saccharose, 1½, 3, and 4½ per cent. gelatine. Thus far only the solution with 1½ per cent. gelatine had been used. The effect on the germination of pollen, especially on the growth and the length of the pollen tubes is obvious. The test which was made with pollen of a very good Malayan Dwarf and a very good Niu Leka, was a combination of preservation in a dessicator with 30 and 40 per cent. of sulphuric acid and germination in the sugar solutions containing 1½, 3, and 4½ per cent. gelatine.

Nearly all through the tests which lasted 16 days for each pollen variety, 4½ per cent. gained on 3 and 1½ per cent., but especially when the pollen was getting older. Four and a half per cent. gelatine stimulated the pollen not only to germinate, but also to grow much longer pollen tubes, and it can be seen that pollen germinated with 1½ per cent. gelatine grew tubes from 3–12 × diameter of the pollen, and the same pollen germinated with 4½ per cent. gelatine formed tubes as long as 22 × diameter of the pollen. In many cases the tubes were as long as 35 × diameter of the pollen grain.

See Tables VII and VIII.

VII.—Test with Pollen from a Malayan Dwarf K. B.8 11/10 which was kept in Dessicators respectively with 30 and 40 per cent. H_2SO_4 and germinated in 25 per cent. saccharose solutions, holding respectively 1½, 3, and 4½ per cent. gelatine.

Date of test.	Age of pollen.	Duration of test in hours.	Per cent. of H_2SO_4 used in dessicator.	Per cent. germination in 25 per cent. saccharose and 1½, 3, and 4½ per cent. gelatine.			Lengths of tubes in 1½, 3, and 4½ per cent.			Temperatures.			
										7 a.m.	Noon.	5 p.m.	Max.
			%	%	%	%							
17/10	6	22½	40	80	75	80	–20	12–16	–40	76	87	78	87
..	..	22½	40	80	75	80	–20	12–16	–30	..	..	..	..
..	..	22½	30	90	80	90	–20	–20	–40	..	..	..	..
..	..	22½	30	90	70	90	–20	–20	–40	..	..	..	..
19/10	8	13	40	70	80	80	–20	–24	–30	75	82	76½	84
..	..	13	40	40	75	75	–12	–20	–24	..	..	..	..
..	..	13	30	60	85	60	–12	–24	–13	..	..	..	..
..	..	13	30	80	85	50	–20	–24	–24	..	..	..	..
21/10	10	11	40	80	70	70	–20	–10	–24	71	80	74	81
..	..	11	40	50	8	70	–12	–8	–24	..	..	..	..
..	..	11	30	80	60	60	–16	–18	–18	..	..	..	..
..	..	11	30	75	30	65	–16	–8	–20	..	..	..	..
23/10	12	10½	40	50	85	85	10–14	12–20	20–30	75½	78	75	83
..	..	10½	40	60	75	75	12–18	12–20	20–25	..	..	..	..
..	..	10½	30	80	90	70	14–20	20–35	15–25	..	..	..	..
..	..	10½	30	80	85	80	12–20	20–30	15–25	..	..	..	..
24/10	13	9½	40	15	30	20	3–15	–18	–16	76½	82	80	83
..	..	9½	40	20	20	40	3–15	–8	–21	..	..	..	..
..	..	9½	30	..	20	35	..	–20	–18	..	..	..	..
..	..	9½	30	2	15	30	3 x	–10	–20	..	..	..	..
25/10	14	11½	40	20	25	60	–14	–12	–16	77	85	82½	87
..	..	11½	40	50	25	65	–20	–12	–18	..	..	..	..
..	..	11½	30	15	28	65	4–8	[illegible]	–22	..	..	..	..
..	..	11½	30	60	40	60	–20	–8	–20	..	..	..	..
27/10	16	13⅜	40	5	30	60	1–2	4–18	6–22	72½	83	79	84
..	..	13⅜	40	12	35	60	6–17	8–22	6–22	..	..	..	..
..	..	13⅜	30	15	50	30	4–16	8–26	6–21	..	..	..	..
..	..	13⅜	30	15	10	35	4–16	3–19	6–21	..	..	..	..

VIII.—Test with Pollen from a Fijian Dwarf (Niu Leka) N.L.Co 16/10 which was kept in dessicators respectively with 30 and 40 per cent. H_2SO_4 and germinated in 25 per cent. saccharose solutions, holding respectively $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent. gelatine.

Date of test.	Age of pollen.	Duration of test in hours.	Per cent. of H_2SO_4 in dessicator.	Per cent. germination in 25 per cent. saccharose and $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent. gelatine.			Lengths of tubes in $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent.			Temperatures.			
										7 p.m.	Noon.	5 p.m.	Max.
			%	%	%	%							
22/10	6	24	40	60	20	80	–18	–14	20–35	71	80	77	82
	..	24	40	60	30	85	–18	–14	20–35	..	..	..	..
	..	24	30	60	70	85	–14	–16	20–30	..	..	..	..
	..	24	30	70	80	80	–16	–20	20–30	..	..	..	..
24/10	8	10	40	60	80	80	–15	–20	–21	$76\frac{1}{2}$	82	80	83
	..	10	40	40	55	72	–15	–16	–20	..	..	..	..
	..	10	30	60	80	65	–15	–17	–24	..	..	..	..
	..	10	30	30	90	55	–9	–19	–21	..	..	..	..
	..	10	30	30	90	55	–9	–19	–21	..	..	..	..
26/10	10	$12\frac{3}{4}$	40	35	5	40	–13	–4	–18	78	83	78	84
	..	$12\frac{3}{4}$	40	5	60	55	1–2	–15	–20	..	..	..	..
	..	$12\frac{3}{4}$	30	8	50	65	–6	–22	–22	..	..	..	..
	..	$12\frac{3}{4}$	30	75	50	75	–18	–20	–22	..	..	..	..
28/10	12	13	40	3	60	60	2–4	6–20	5–22	76	84	80	86
	..	13	40	35	40	60	6–16	3–18	5–22	..	..	..	..
	..	13	30	40	65	35	3–20	8–20	6–22	..	..	..	..
	..	13	30	35	55	55	3–15	4–17	6–24	..	..	..	..
29/10	13	13	40	35	55	70	4–13	4–18	6–22	78	85	80	87
	..	13	40	35	65	72	5–12	6–18	6–24	..	..	..	..
	..	13	30	40	60	60	4–14	6–20	6–24	..	..	..	..
	..	13	30	35	64	50	4–12	6–22	6–20	..	..	..	..
30/10	14	13	40	12	25	16	3–14	6–20	3–11	75	80	75	80
	..	13	40	15	20	30	6–17	6–18	4–18	..	..	..	..
	..	13	30	25	22	40	3–12	4–16	6–20	..	..	..	..
	..	13	30	30	20	40	4–16	4–12	6–20	..	..	..	..
1/11	16	$12\frac{3}{4}$	40	8	15	6	3–12	3–17	3–24	76	79	77	82
	..	$12\frac{3}{4}$	40	8	25	8	3–12	5–23	4–32	..	..	..	..
	..	$12\frac{3}{4}$	30	12	35	18	3–14	3–22	4–18	..	..	..	..
	..	$12\frac{3}{4}$	30	22	35	5	3–18	3–22	4–10	..	..	..	..

Thus it is possible to keep 35 to 60 per cent. of pollen viable during at least 16 days in dessicator with from 30 to 40 per cent. sulphuric acid. This will enable us to carry out pollinations with pollen from trees growing on islands in this group far away from the mother trees. The pollen has then to be carried in special dessicators, so that shaking does not bring the sulphuric acid in contact with it while continually kept in full daylight.

Tests carried out with pollen taken from the first spathe of coconut trees gave no germination at all, which confirms the general opinion, that pollen from the first spathe of a tree is sterile. The first spathe has never been found to bear female flowers.

Pollinating Agents.

While examining a spadix in bloom one will be astonished to find a large number of different insects visiting both the male and female flowers. Among the visitors must first of all be mentioned the hornet, further the domestic bee, a much smaller wild native bee, a small fly, a green beetle known as Japanese rose beetle, different sorts of ants, earwigs and a red and black wasp. Other regular visitors are lizards and a very small bird. Specimens of all the insects were examined and it was found that only the two sorts of bees and the little fly carried coconut pollen.

Several bees caught on the wild flowers growing under the trees were examined for pollen but the bees taken from the sensitive grass (*Mimosa pudica*) nearly always carried pollen of these flowers only. The same was found with bees visiting the blue rat-tail (*Stachytarpheta*), Kosters curse (*Clidemia hirta*), *Lantana camara*, and a *Malva* variety. Sometimes I found a few of these pollens mixed, but never did I detect any weed pollen among the coconut pollen. The flowers of these weeds are all on practically the same level over the ground.

Bees visiting coconut trees apparently find sufficient work there, not to be bothered with other plants. This is perhaps a matter of specialising in collecting only one sort of pollen. It is the pollen which they carry in the hairs on the body which comes on the stigmas, not the pollen they carry in cakes in the baskets on their legs. It is a certain fact that bees, which have been visiting male flowers for pollen and nectar, also visit female flowers for nectar, and in going from one drop of nectar to the other two, on the same female flower, they cross the stigmas and thus actually pollinate them. Often in certain positions of the female flowers, the nectar drops grow too large and run over the stigmas. Bees may be seen cleaning such nectar from the stigmas, thus helping the pollen which is left on them to germinate and deterring destruction by the nectar.

The hornets, by some authors supposed to assist in pollinating, do not carry pollen, although they have a few hairs on the legs. They only rob the flowers of pollen and honey, and prey on the bees and ants and other insects. In keeping the bees away from the flowers, hornets do much harm. The bees which certainly assist in pollinating the stigmas are as a rule not very numerous on coconut plantations, and the hornets who are only robbers prevent even these few from doing their valuable work.

I do not think that ants help in pollinating. If they carried pollen at all, they could only deposit it on the stigmas of the same spadix, as they do not travel from one tree to another. I have often noticed ants walking over the stigmas notwithstanding the secretion from the numerous pores round the stigma, which according to Petch form a ring of fluid around them keeping the ants away.

On Taveuni, where there are so many rain-days, and besides many days of dull weather, the bee as a pollinator is essential to the coconut cultivation. More bees and fewer hornets would undoubtedly have a favourable influence on the nut production.

The abundant production of honey and pollen point ubdoubtedly to insect pollination as does the scent spread by the honey. But on the other hand the enormous number of male flowers compared with the number of female flowers and the extremely large quantity of pollen which, at the least puff of wind spreads in clouds of dry powder through the air, are an indication

for wind pollination. V. C. Aldaba in the Philippines proved by experiments that comparatively few pollen grains reach the stigmas, when pollinated by the wind. However, the wind must be held responsible for most of the pollinations which occur on dull and rainy days when very few insects are about.

Self-Pollination.

Self-pollination of coconuts takes place if pollen of a spathe pollinates the stigmas of the flowers of that same spathe or if pollen of a certain spathe pollinates the stigmas of the flowers of another spathe of that same tree. It will not be difficult to see that the first case is only possible if the male phase overlaps the female phase of the same spathe. This is really the case with the Malayan Dwarfs but not with Niu Lekas. The second case would be possible if pollen of a certain spathe was being shed while the preceding spathe has still receptive female flowers. This, however, has not yet been observed by me. It does happen with Niu Lekas that a spathe opens before the female phase of the preceding one is ended, but as it takes from 7 to 10 days before the male phase of the new spathe begins the female phase of the old spathe by that time is well finished. Thus self-pollination between them is impossible.

It is mentioned by Dr. Hunger in his book "Cocos nucifera" that Dr. P. van der Wolk had success in Java with self-pollinating and according to H. W. Jack it is the rule in the Federated Malay States. This author, however, does not tell how he arrives at this conclusion.

Trials were made with artificial self-pollination by me on Malayan Dwarfs on Mua plantation in Taveuni. A spathe was emasculated just before the female phase set in and the pollen thus cut off was collected and preserved and used for pollinating the stigmas, but at first without any results. After that a spadix was bagged with branches and all, and the male flowers left to open in the bag. Part of the pollen fell out of the anthers but as there was no wind inside the bag, most of it remained in the male flowers. Therefore the branches were shaken so that much pollen fell on the stigmas. This time some results were obtained but much fewer than were expected. As no insects could enter the bag and no honey was taken away a very sticky condition of spadix and bag resulted. More trials were made by applying emasculation and better results ensued. Considering that everything was done to facilitate selfing, the results were rather poor and it seems to me that uncontrolled, natural selfing, at least in Fiji, is not the rule with Malayan Dwarfs.

Cross Pollination.

When inspecting different coconut plantations it will be found very difficult, if not impossible, to detect two trees alike or nearly alike. There are nearly as many types of coconuts as there are trees and this fact points very strongly to cross pollination. It is possible to classify them as talls and dwarfs, late-bearing varieties and early-bearing, also as red, green and yellow nut bearing trees, but for the rest there is nothing which justifies a grouping in a limited number of varieties.

No intentional breeding has been done in Fiji so far and the seed used for planting the existing plantations was taken from close by without considering the origin. Only in a few instances has seed been selected so far. Sometimes only large nuts have been planted or nuts only from heavy bearing trees, but it is obvious that even the best selected seed is of unknown parentage, at least on the male side. Besides, many a traveller has brought

nuts from Samoa, Tonga, Rotuma and other places, from trees which for some reason or other struck his fancy, and planted them between tall coconuts or Niu Lekas on his plantation. Later the man has sold his property and the next owner has known nothing of these imported trees if he ever detected them. Where such conditions prevail the seed material is very variable and unsuitable for planting up new plantations. Uncontrolled cross pollination must be considered the rule in these islands and the cause of the existing conditions.

Artificial Pollination.

In order to obtain reliable seed material, pollinating has to be controlled and this can be done by artificially pollinating the stigmas with pollen of known and selected trees.

Preparations.

In order to perform artificial pollinations certain preparations have to be made, to keep insects at a safe distance, also to prevent undesirable pollen from coming in contact with the stigmas. Therefore all the male flowers must be removed not forgetting the ones situated alongside the female flowers. The branchlets are cut off about half an inch above the female flowers with secateurs or a sharp knife, so that the cut wounds are very clean. As far as my observations go, emasculation has no visible effect on the growth of the female flowers nor does it cause any damage to the spadix in general. It must be understood that the male flowers may remain on the spadix until a few days before the female phase begins. This can be estimated fairly accurately within two or three days. Emasculation being done the spadix must be thoroughly cleaned, and all diseased or half eaten flowers, also borers and borer dirt, earwigs, ants and any other insects must be removed. To prevent interference from insects a bag must be fastened around the spadix. If ants are to be kept from entering the bag during the receptivity of the female flowers, tanglefoot may be applied around the stalk outside the bag.

It was found in connection with the shape of the coconut trees, also the lengths and placing of the spadices, that it was best to make the bags from 10 to 12 inches wide and from 3 to 3½ feet long. Further, it was necessary to open and close the bags quickly in order to perform the pollinations and make observations, without removing them. A suitable bag was constructed in which two copper rings of 10 to 12 inches diameter run through small brass rings, in order to hold the bag open. An overlap of 6 inches is sufficient to prevent insects entering. The bottom end of the bag is fastened around the clean stalk of the spathe while the top is tied to at least three midribs of leaves.

To make the placing and fastening of the bag easier the female flowers of the two or three lowest branchlets are removed. These flowers, as a rule, are smaller and a little backward and obstruct the proper fastening of the bag around the stalk. I tie this end of the bag with a thin sail-maker's string, taken double, which though rather expensive, proves to be cheap in the long run, because it can be used for several months on different spathes in all weather without deteriorating. The overlap is fastened with enough pins to keep insects out.

To open the bag in order to examine the spadix or to pollinate, the flap, after removing the pins, is pushed to the right while the other edge is pushed o the left, the small rings sliding easily over the copper-wire rings. The

opening must not be wider than necessary, and if there is wind which may be disturbing to the act of pollinating, or carry foreign pollen inside the bag, and perhaps on the stigmas, it is advisable to shut the wind out by opening only one side of the bag. The bag should be fastened in such a way that the opening comes on the ventral side of the spathe, that is the side facing the subtending leaf. An advantage of this type of bag is that the original shape and position is retained after opening and closing. I have been using this type of bag for fifteen months, and find it very satisfactory.

According to Dr. P. van der Wolk it is possible to cause the female flowers to ripen earlier than usual just by covering them with black paper. Perhaps the application of a white cotton bag has a similar effect on the female flowers, although such a bag does not keep the flowers in the dark. But if the flowers are speeded up in becoming receptive as a result of the bag this can be only an advantage because the pollen can then be used somewhat sooner.

Pollinising.

Stigmas can be artifically pollinated with a No. 1 camel hair brush. The smallest possible quantity of pollen is taken with the brush from the glass tube and carefully placed on the moist narrow ribs of the stigma. Sometimes it is necessary to repollinate a few stigmas after the whole spadix is done, because one cannot avoid shaking the spadix and knocking some of the pollen from the pollinated stigmas.

If the distance from laboratory to the field may be traversed in no more than half an hour the glass tubes containing the pollen may safely be taken from the dessicator, and quickly closed with a well fitting cork stopper and so carried to the trees, but if the distance requires more than half an hour it is advisable to close the tubes with paraffined or rubber stoppers.

For long distance the pollen will have to be transported in a special dessicator, of such a construction that shaking cannot bring the sulphuric acid in contact with the pollen. The following construction proved rather suitable: A Wolff bottle with two necks is half filled with the required 35 per cent. sulphuric acid solution while two thin glass tubes bent at right angles fit in two rubber stoppers in the bottle. Two wide glass containers holding the small tubes with pollen are also fitted with rubber stoppers and thin glass tubes bent at right angles while pieces of rubber tubing connect the glass tubes. The rubber tubing can be pressed together with metal clips, so that no sulphuric acid can pass through. The whole is placed in a wooden box with glass walls and a handle on top. When the atmospheric condition in the glass containers is the same as in the Wolff bottle the clips are placed on the rubber tubing and the dessicator can stand much shaking without any danger.

Available Varieties.

The varieties of coconuts on which I was to experiment on Mr. F. Duncan's plantation, Mua, on Taveuni, were the so-called Malayan Dwarf, an imported variety from the Federated Malay States, and the Fijian Dwarf or Niu Leka. The trees were planted in January, 1922, and it was in August, 1925, that the first tree commenced flowering. In August, 1926, there were 48 trees flowering, and in bearing, of which 21 were selected for experiments.

There are two types of Malayan Dwarf: one with apricot coloured nuts and a yellow or reddish hue all over the spathe stalks, and mid-ribs, and another with slightly smaller, greenish or ivory-yellow nuts, and a paler

green colour in stalks and mid-ribs. Of the latter type only one tree was used for experiments. The nuts of both types have the same shape—that is, round on transverse section and oblong on longitudinal section, slightly pointed at both ends.

In an essay on Dwarf Coconuts in the "Malayan Agricultural Journal," Vol. XII, No. 11, November, 1924, H. W. Jack points out that there are three distinct types of Malayan Dwarf, apricot, green and ivory-yellow. "These Malayan Dwarfs are locally known in Malaya as Niur gading, and are supposed to have been imported from Java, district Krian." Further on he writes: "On existing plantations these types are intermingled with each other and with ordinary talls and semi-talls though the ivory-yellow type predominates." The Malayan Dwarf could, except for the three colours in nuts, be called a pure line.

The Niu Lekas, however, is a group, or population, with distinct types, although all are more or less early bearing. It may be possible to divide these Niu Lekas according to colour, and shape of the nuts and the diagrams of the spathes into groups. Though these groups are certainly not pure lines, through breeding from distinct types only and by keeping them well isolated, it may be possible to obtain very useful material for crossing with other good types, or with imported strains.

There are many types among the Niu Leka with rather short leaves, though the majority have heavy mid-ribs with a broad foot gripping round the stem of the tree. The general appearance of the crowns is heavy and dense, but strong. However, a few trees can be found with slightly longer leaves, thinner mid-ribs and a much more open crown, with long spathes, being at the same time fairly heavy producers.

The inflorescences of the Niu Lekas differ in many ways from those of the Malayan Dwarfs. Not only are there red and green nuts, round and long shaped nuts, trees with heavy dense crowns, and trees with open, airy crowns, long leaves with thin mid-ribs and short leaves with very heavy and broad mid-ribs, but all these types have variable inflorescences.

The diagrams show some of the variations very plainly. The number of branchlets of the spadices varies from 49 to 76. Some trees have never more than one female flower per branchlet—others have no female flowers on the first 10 to 14 branchlets. Again others have very few female flowers on the lower branches, or very few on the top branches. Or one spadix may have 58 branchlets all crowded on a stalk 30 inches long, while other trees have only 50 branchlets on stalks of 5 feet in length. In the latter case the nuts will have more room for development and less chance of pushing one another from the stalk.

The shape and size of the female flowers of the Niu Lekas varies greatly. As a rule the stigmas are smaller than those of the Malayan Dwarfs, although the female flower in full receptivity may be larger.

The male flowers of the Niu Lekas are mostly different from those of the Malayan Dwarfs. They are not so pointed as a rule, and placed closer together and very often in pairs. When the branchlets are very short, and the number of flowers large, they are so crowded together that they take a shape according to the space they have to develop in. In general, the Niu Lekas have more male flowers on a branchlet than the Malayan Dwarfs, and the branchlets also are more numerous; consequently, there is a greater abundance of pollen in the Niu Leka spathe, which makes collecting easier.

Another rather early bearing variety which may prove very useful for breeding purposes is the Rotuma nut. There happened to be a complex of about 40 acres of Rotumas on Mrs. Mackenzie's Plantation, Nagasau on Taveuni, where I was kindly offered the opportunity to make pollination experiments.

The Rotumas bear a larger size nut than the ordinary tall coconut and with thicker meat. In order to breed improved Rotuma stock it will probably be advisable to carry out artificial pollinations on selected superior types on the island of Rotuma, where in all probability the variety has been kept rather pure through the isolation of the island.

On a fourth local variety, the common tall Fiji coconut, no pollination experiments have as yet been carried out. For such a purpose it will be necessary to produce a complex of young trees not too high, kept in so good a condition that very healthy superior types may be selected.

Selection of Superior Trees.

Breeding superior stock means breeding coconut trees with an average yearly yield of oil higher than the present average. It would take a very long time and much expense to analyse meat of all the good trees on a plantation in order to find the highest yielders, but it is generally taken for granted that a tree with a large number of large nuts with thick kernel will produce a large quantity of oil. This may eventually be found not to be the case. Such an assumption, however, simplifies greatly the selection of trees for breeding. Since the acid test is a large average yield of copra, per acre, trees must be sought which produce a large number of large nuts of a thin husk and a thick kernel, and which lend themselves to close planting. Trees just coming into bearing should not be selected, because an optimum or maximum production is not reached for several years after the first spathe appears, or that, at least, is the general opinion of authors.

When a number of trees of apparent high yield have been selected their relative merits can be more accurately gauged by calculating the theoretical yearly yield of wet copra which would be produced per acre if the trees under consideration were reduplicated in plantations. If all the ripe nuts obtainable for each tree be measured and weighed, and the wet copra cut from such nuts be weighed an average weight of whole nut and an average weight of copra per nut can be obtained for the several trees. To estimate the number of nuts which the several trees would produce in a year all visible nuts of every age should be counted for each tree, that number divided by the number of spadices involved (to get the number per spadix) and then multiplied by twelve (as one spathe is put forth each month). A third factor to be determined is the number of trees of the patterns selected which could be grown per acre of land. The theoretical yearly yield then is the product of these three factors, viz., the average weight of wet copra per nut, the estimated number of nuts per year, and the estimated number of trees per acre.

All these high yielders are subsequently selected on the basis of habitus, shape, density or openness of the crown, length and thickness of the mid-ribs, length of spathe, also number and placing of the female flowers. Here the diagrams of the spadices of each tree are of great help showing numbers, irregularities, if any, and whether a tree tends to "go off" sometimes, as the planters call it, when a tree stops producing female flowers and even spathes temporarily. All the diagrams of the Malayan Dwarfs are alike,

proving that this variety approximates a pure line, which made selecting very easy, because only the healthiest and strongest trees were to be picked. Similar diagrams were made of apparently the best Niu Leka trees, and from the diagrams were chosen those which showed a large number of female flowers with the greatest regularity, and with a tendency to increase the number of female flowers, and to produce more than one female flower on the same branchlet. The same selection was applied to the Rotumans at Nagasau where two superior trees were selected.

The number of trees per acre varies with the variety. The usual distance in Fiji for common coconuts is 30 feet, but many Niu Lekas do not require more than 24 or 25 feet while Malayan Dwarfs on account of the short leaves may be planted at 20 feet.

In the following table the theoretical yearly yields of wet copra per acre are calculated for the trees which were selected for breeding improved stock:—

Coconut variety.	Average total weight per nut.	Average weight of meat per nut.	Average number of nuts per tree.	Yearly yield of wet copra per tree.	Plant distance in feet.	Number of trees per acre.	Theoretical yearly yield wet copra per acre.
	lb–oz.	lb–oz.		lb			lb
Malayan Dwarf ..	2–12⅜	0–12¾	72	57⅜	20	108	6,196½
Niu Leka C.o.	5– 9	1– 4	90	112½	30	48	5,400
Niu Leka E.3.	3–15	0–15	106	100	30	48	4,800
Rotuma, Green ..	5–12	1–10	78	126¾	30	48	6,084
Rotuma, Red	4– 2½	1– 2⅜	60	70	30	48	3,360
Common Coconut ..	..	1– 0	42	42	30	48	2,016

These yield figures being obtained by multiplication, are naturally very unreliable and consequently can be used only comparatively. When comparing these yields with those of the average plantation tree, producing 42 nuts per year, and having an average of 1 lb of wet copra per nut, which is probably too high, it will be seen that they are all much higher.

The practice of selecting useful parent trees by sight, even considering the inflorescence and the yearly yield of copra, does not guarantee a uniform plantation. The seedlings of the same parent trees will vary considerably on account of uncontrolled cross pollination. Only by cross pollination or selfing practiced on the parent trees artificially is a more uniform offspring to be expected, although even then the influence of the grand-parents will be noticeable. Intercrossing of the daughter trees is then the means of eliminating undesirable qualities.

Pollinations on Malayan Dwarfs.

The few tests which I made around Suva, in 1928, were not satisfactory, as the trees used were in a very poor condition, and the pollen of these trees consequently lacked much in vitality. On Taveuni, conditions are different. The selected Malayan Dwarfs are all rather healthy, and if pollinations could not be made on all available spathes, this was due to much damage

by moths, or to weather conditions. Until the beginning of October, 1925, I was unable to test the different pollens, because the germination solution I took with me from Suva, apparently being too old, did not give satisfactory results. Thus all the pollinations made before that time were made on the off-chance. From 230 pollinated flowers on Malayan Dwarfs during that period, 54, that is 23·5 per cent. became fertilised. They were counted eight weeks or longer after pollinating and it is not likely that any more drops would occur after that period unless caused by injurious insects, rats, crabs, &c. After October, 1925, the pollen used for pollinations was tested as regularly as possible and only pollen of a high percentage of germination in a solution of 25 per cent. saccharose and 4½ per cent. gelatine was used.

Undoubtedly a large number of the failures are the results of pollinating flowers which were not yet fully receptive or already past receptivity. A number of the other failures and probably not the smallest, is due to dull weather on rainy days when the temperature is low.

Pollinations on Niu Lekas.

In 1926, on 14 Niu Leka trees, 382 pollinations were made. The flowers were all pollinated with pollen from Malayan Dwarfs. At the end of 1926 nothing could be said with certainty about the results as some of the nuts were still likely to fall. Now all the nuts pollinated in 1926 have been collected during 1927, and of those pollinated in 1927 it can be said of a good many, with certainty, that they will remain on the trees.

The following tables show in light figures the numbers of pollinations made in the different months on the various trees of Malayan Dwarfs, Niu Lekas, and Rotumas. The black figures give the numbers of the resulting nuts and where black figures are absent the number of resulting nuts was not to be told with certainty. However, calculating the probable results at the same rate as the certain nuts, I was able to estimate the probable total of each variety which will be available by the end of 1928, being for Malayan Dwarfs, 289 or 27·25 per cent.; for Niu Lekas, 97 or 34·1 per cent.; and for Rotumas, 42 or 30·9 per cent.:—

Table I.—Pollination and Resulting Nuts thereof on Malayan Dwarf Coconuts, Mua Estate, Taveuni.

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
A6	15	3	11	1	2	0	14	2	..	..	15	7	..	..
B6	37	10	3	0	8	2	9	4	5	2	16	10	..	..
B7	18	4	8	4	15	6	15	8	14	6	..	..	..	..
B8	24	4	16	3	10	..	..	..	..	..	26	..	..	..
D2	..	..	..	..	..	..	3	..	..	..	..	..	13	..
D7	27	6	9	3	..	..	..	..	..	..	19	..	16	..
E3	14	2	..	..	..	..	13	..	..	..	2	..	11	..
E5	18	3	7	..	..	..	..	..	8	..	..	..	6	..

TABLE I—*continued* :—

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
E6	..	..	..	..	11	..	..	..	..	..	11	..	8	..
E7	21	6	..	..	..	..	..	..	..	..	..	..	..	..
F2	..	..	..	..	..	..	..	..	..	..	..	..	10	..
F3	..	..	..	..	10	2	..	..	..	..	..	..	9	..
F7	19	5	..	..	21	3	1	..	15	..	..	..	..	..
G4	15	6	..	..	..	..	..	..	11	..	..	..	..	..
G5	..	..	..	..	22	4	7	..	14	..	3	..	..	..
G6	23	5	..	..	..	..	9	..	12	..	5	..	..	..
G7	17	1	..	..	..	..	14	5	..	..	27	..	17	..
H6	19	5	..	..	16	7	..	..	10	..	19	..	..	..
Certain	267	60	47	11	94	24	52	19	19	8	31	17	..	..
Uncertain	..	..	7	..	21	..	33	..	70	..	112	..	90	..
Totals	267	..	54	..	115	..	85	..	89	..	143	..	90	..

TABLE I—*continued* :—

Tree.	October.		Nov.		Dec.		Totals per tree.		Totals of nuts.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
A6	..	..	..	..	12	..	71		.....
B6	11	0	..	..	11	..	100		.....
B7	6	..	6	..	11	..	93		.....
B8	25	..	15	..	..	..	116		.....
D2	..	..	..	..	..	..	16		.....
D7	13	..	9	..	..	..	91		.....
E3	..	..	..	..	..	..	40		.....
E5	..	..	..	..	..	..	39		.....
E6	12	..	4	..	..	..	46		.....
E7	9	..	..	..	18	..	48		.....
F2	..	..	..	..	..	..	10		.....
F3	..	..	..	..	..	..	19		.....

TABLE I—*continued :—*

Tree.	October.		Nov.		Dec.		Totals per tree.		Totals of nuts.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
F7	..	..	..	..	..	..	56		.....
G4	..	..	..	..	..	..	26		.....
G5	..	..	11	..	..	..	57		.....
G6	10	..	..	..	11	..	70		.....
G7	16	..	10	..	..	..	101		.....
H6	..	..	..	..	..	..	64		.....
Certain	..	..	..	..	..	..	510	139	27¼% A
Uncertain	102	..	55	..	63	..	553	150	B
Totals	102	..	55	..	63	..	1,063	289	probable total

TABLE IIA.—POLLINATIONS AND RESULTING NUTS THEREOF ON NIU LEKA COCONUT TREES. MUA ESTATE, TAVEUNI.

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
Co	..	..	..	..	43	11	16	7	21	8	16	..	16	..
E3	..	..	..	..	..	..	..	..	..	..	25	..	22	..
F6	20	3	15	6	11	8	..	..	..	..	..	..	..	..
Certain	20	3	15	6	54	19	16	7	21	8	..	..	..	..
Uncertain	..	..	..	..	..	..	..	..	..	..	41	..	38	..
Totals, month .	20	3	15	6	54	19	16	7	21	8	41	..	38	..

TABLE IIA—*continued :—*

Tree.	October.		Nov.		Dec.		Totals per tree.		Per cent.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
Co	16	..	..	..	20	..	148	..	.....
E3	20	..	24	..	..	..	91	..	.....
F6	..	..	..	..	..	..	46	..	.....
Certain	..	..	..	..	..	..	126	43	34·1 per cent.
Uncertain	36	..	24	..	20	..	159	54	Calculated at the same rate.
Totals, month .	36	..	24	..	20	..	285	97	Probable total.

TABLE IIb.—POLLINATIONS AND RESULTING NUTS THEREOF ON ROTUMA COCONUT TREES, NAGASAU.

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
Rotuma, Green	..	..	..	..	14	4	12	6	..	..	12	6	4	2
Rotuma, Red .	..	..	..	..	14	3	14	4	15	4	13	1	15	5
Certain	..	..	..	..	28	7	26	10	15	4	25	7	19	7
Uncertain	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Totals, month .	..	..	..	..	28	7	26	10	15	4	25	7	19	7

TABLE IIb—*continued* :—

Tree.	October.		Nov.		Dec.		Totals per tree.		Per cent.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
R. green	..	..	..	..	..	..	42	..	.....
R. red	12	..	10	..	..	..	93	..	.....
Certain	..	..	..	..	..	..	113	35	3·9 per cent.
Uncertain	12	..	10	..	..	..	22	7	Estimated at the same rate.
Totals, month .	12	..	10	..	..	..	135	42	Probable total.

SUMMARY.

1. Coconut pollen germinates best in a 25 per cent. saccharose solution containing 4½ per cent. gelatine.

2. Clean pollen of a healthy coconut tree stored in a dessicator containing 35 per cent. sulphuric acid was found viable after 16 days with a germinating power in above-mentioned solution of from 35 to 60 per cent.

3. Uncontrolled pollinating is established by wind as well as by insects, especially by bees and a small fly.

4. Bees being essential for performing pollinations in order to obtain a higher yield of nuts, bee-keeping ought to be encouraged among coconut planters.

5. For controlled pollinating only pollen of a high vitality should be used.

6. Coconuts can be grown in Fiji by means of artificial pollination.

7. Uncontrolled selfing is possible with Malayan Dwarfs, but impossible with Niu Lekas and Rotumas. Controlled selfing is theoretically possible

with any coconut variety as long as the interval between the male and the female phase of the same spathe is shorter than 16 days.

8. The results obtained in Taveuni with cross pollinating between Malayan Dwarfs (female) and Niu Lekas (male) was 27¼ per cent., between Niu Lekas (female) and Malayan Dwarfs (male was 34·1 per cent., between Rotumas (female) and Rotumas (male) was 30·9 per cent.

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DERMATITIS IN CATTLE IN FIJI.

By Chas. R. Turbet, B.V.Sc., Government Veterinary Officer.

In previous experiments conducted in July to November, 1925, and duly reported to the Superintendent of Agriculture, I failed to reproduce the condition of Dermatitis in cattle and to determine the cause. In these experiments, however, the eight cattle used had been born and raised in the vicinity of Suva. I have been impressed since then with the fact that the disease occurs chiefly among animals which have been subjected to hardship or change of habitat such as occurs when these are brought to Suva or some other place by boat, or overland. It is assumed that these animals are in a state of partial starvation, lowered vitality and possible slight gastro-intestinal disturbance. Also the possibility existed that local animals are tolerant to the toxic principle causing the condition, and that this tolerance was not shared by animals reared in other districts.

In the experiments now conducted I secured eight calves about six months old from Navua and transported them by punt to the Quarantine Station at Suva so that the conditions would resemble as nearly as possible to those under which animals previously had been naturally affected. The calves had a particularly quick trip from Navua and arrived in good condition. In addition to the eight calves from Navua, two calves born at the animal quarantine station were included in the experiments.

I had previously had erected at the quarantine station four adjacent pens about 12 feet square. The grass within these pens was cut to ground level. A minimum of shade was provided, one sheet of iron diagonally across a corner of each pen and a 4 feet square of hession suspended to throw a square of moving shade.

The calves arrived at 4.30 p.m. on 30th December, and were distributed and fed as follows:—

Calf No.	Pen No.	Feed given.	Colour.	Remarks.
1 2	1	Sensitive plant (*Mimosa pudica*) *ad lib.*	Black and white, white muzzle. Do.	
3 4	2	*Lanvina camara*, Para grass in equal parts, chopped, one benzine tin of each twice daily.	Black and white, black muzzle with small white area. White and black, black muzzle with small white area.	Small proportion of rice bran given to improve the flavour.
5 6	3	Leaves and pods of Rain tree (*Albizzia lebbeck*) *ad lib.*	Black and white, black muzzle. Do.	
7 8		Running on grass in the main Quarantine Station paddocks.	Red and white, light-brown muzzle. Do.	Dipped. Not dipped.
9 10	4	Mixed grasses, *ad lib.*	Brown Jersey colour. White ring around nose. Black and white, black muzzle.	Both dipped as a control against the assertion that dipping caused the disease.

The following observations were made on their subsequent behaviour and condition:—

December 31*st*, 1927.—No symptoms showing in any calves, but those on *Lantana*, Nos. 3 and 4 not relishing their food.

January 1*st*, 1928.—No symptoms. All animals eating well except those on *Lantana*. These latter, however, consumed a considerable portion of their rations.

January 2*nd*.—The two calves, Nos. 3 and 4, on *Lantana*, feeding better.

January 3*rd*.—No change.

January 4*th*.—Calf No. 3 on *Lantana* constipated. Calf No. 4 to a lesser degree.

January 5*th*.—No further change.

January 6*th*.—No further change.

January 7*th*.—Calves Nos. 3 and 4 on *Lantana* off their feed, one lying down with head stretched out, slight grinding of the teeth heard from both, both constipated.

January 8*th*.—Calves Nos. 3 and 4 on *Lantana* obviously ill, not eating, slight swelling of skin of muzzle, particularly of the white patches, yellowish exudation from the skin of muzzle, catarrhal exudate from the nostrils and eyes, slight icterus, flies swarming around the eyes, skin of white areas of back of No. 3 inflamed and hardened by serous exudate, in marked contrast to the black areas of skin which was still soft and supple, frequent small emissions of bile-stained urine.

January 9*th*.—Condition of the two calves on *Lantana* slightly worse, symptoms of Dermatitis distinct but not as markedly pronounced as in some other naturally occurring cases.

January 10*th*.—No marked change in condition of the sick animals. All the other animals included in the experiment remain healthy.

January 11*th*.—In the morning I took Mr. Thomas, retired Meat Inspector, to see the experiment. He had seen a considerable number of cases of Dermatitis. I showed him all the animals in the different pens and asked him whether he thought any were sick. He indicated the two on *Lantana* as being ill. To my question as to what he thought was wrong with them, he immediately replied "Dermatitis." In the afternoon I took Mr. Mune, Manager of Leyland's Limited, Butchers. His replies to my questions were the same as Mr. Thomas'.

January 12*th*.—I invited Dr. Tothill, Superintendent of Agriculture, and Mr. Ellis, Meat Inspector, who had seen a lot of the disease, to go with me to the quarantine station to see the experiments. On arrival I found that calf No. 3, one of those feeding on *Lantana* had died.

The remaining live calf, No. 4, in the *Lantana* pen was examined, the lesions on the calf were not pronounced. The mucous membrance of the eye were slightly icteric, catarrhal exudate from the nostrils which showed the typical swollen brownish-yellow coloration, the white patch on the black muzzle was swollen and covered with a yellowish-brown exudate, necrosis of the superficial cells was evident. Although this calf was more white than black the only skin lessions were a small cracking of the skin in a transverse direction on top of the withers on a white area. The pigmented skin in the same region adjacent to the lesion not affected. Yellowish serum exuded from these cracks.

Mr. Ellis gave as his opinion that both animals were affected with Dermatitis, thus confirming my own diagnosis.

A post-mortem examination was conducted on the carcase of the dead calf by myself and Mr. Ellis.

AUTOPSY.

The external lesions have already been noted. There was a small necrotic ulcer-like patch on the gums of the upper incisors, the subcutaneous tissues were not as markedly icteric as in some cases of Dermatitis, although the colouration was distinct enough, particularly in patches in the intermuscular septa and on the course of lymphatics and in joint capsules. The muscles were discoloured. The mucous membrance of the rumen peeled off on taking it in the fingers as though it had been scalded with boiling water. The omasum was apparently normal (an excessive dryness has been noted in most naturally occurring cases). The mucous membrance of the abomasum, particularly towards the pyloris was inflamed slightly and along the course of the small intestine was a more or less diffuse slight inflammation, not very severe in any part. The chief lesions were found as usual associated with the liver and gall-bladder.

The liver was enlarged, friable, slightly mottled and of a dull yellowish-red colour. The colouration was not as pronounced as in other naturally occurring cases which I have examined, some of which could well be described as ochre-yellow.

The gall-bladder was greatly enlarged, holding about 40 ounces of bile (calf six months old). The wall was stretched to extreme thinness and in parts was bile-stained on the outside as though bile were weeping through.

The organs in contact with the gall-bladder were all definitely bile stained. The bile was thick and viscid, there was no definite blockage of the bile duct, although there was a certain amount of catarrh of that passage. The kidneys and spleen were normal. The pancreas was bile stained, probably from its proximity to the gall-bladder. In the abdominal cavity there was a small amount of bile stained serous erudate. The bladder was distended and urine bile stained.

These findings agreed in major detail with other findings at autopsys on animals dead of Dermatitis.

January 13th.—The other calf, No. 4, ill with Dermatitis, no worse. All other animals under experiment still healthy. No. 4 was fed plain grass.

January 15th.—Calf No. 4 was fed plain grass and was slightly better.

January 19th.—Calf No. 4 almost well again. Exfoliation of dryed scab from muzzle and anterior nares and withers left healthy tissue beneath. Slight desquamation of epidermal scales from backs of ears—indicate that there has been a slight serous exudate there which I had not discovered previously. That would conform to the usual findings.

I consider that this had completed the first part of the experiment and calf No. 4 was turned out to grass and was not utilised in the next series which I undertook.

All through these experiments the calves, Nos. 1, 2, 5, 6, 7, 8, 9, and 10, remained healthy. The two calves, Nos. 3 and 4 affected were in No. 2 pen between pens Nos. 1 and 3 containing calves Nos. 1, 2, and calves Nos. 5 and 6 respectively. These were fed sensitive plant and rain tree respectively. The calves dipped as a control remained healthy. The calves

running loose in the station paddock, where natural occurring cases had occurred, were not affected.

The amount of *Lantana* growing in the quarantine station was scanty. There were but few seedlings from six inches to a foot in height. On the seaward side of the station, however, between the fence and the sea wall, an area varying in width from three to twenty feet, a considerable amount of *Lantana* was growing. On examination it was found that cattle could easily have reached this *Lantana* by thrusting the head through between the wires of the fence.

Conclusions.

The condition known as Dermatitis affecting cattle in Fiji is caused neither by the ingestion of the sensitive plant (*Mimosa pudica*) nor the leaves or pods of the rain tree (*Albizzia lebbeck*), nor by the effects of dipping in Cooper's Cattle Dip 1/150 dilution giving a strength of As_2O_3 of ·19 per cent.

Two calves fed on *Lantana camara* contracted Dermatitis whilst eight other calves under practically similar conditions and in close proximity but fed on other fodder remained healthy (*Lantana camara* has been present in all paddocks where Dermatitis has occurred).

From these results I conclude that the ingestion of *Lantana camara* can cause the conditions known as Dermatitis affecting cattle in the Suva and Lower Rewa districts of Fiji.

FURTHER EXPERIMENTS.

In order to put the question beyond doubt it was decided to conduct a further series of experiments to determine:—

(*a*) the quantity of *Lantana* required to be ingested to produce the disease known as Dermatitis;
(*b*) the variation in susceptibility of a number of animals;
(*c*) whether Suva-bred animals had any immunity or tolerance of the disease.

To that end calves Nos. 1, 2, 5, 6, 7, 8, 9, and 10 were utilised and distributed as follows:—

Calf No.	Pen No.	Feed.	Remarks.
1	1	Equal parts of *Lantana camara* and Guinea grass.	Calf No. 2 showing signs of severe worm infestation.
2	1	Do.	.....
5	3	Equal parts of *Lantana camara* and Guinea grass.	.....
6	3	Do.	.....
8	4	Equal parts of *Lantana camara* and Guinea grass.	.....
9	4	Do.	Calf No. 9, Suva bred animal.
7	At large	Mixed grasses.	Control.
10	Do.	Do.	.....

On 20th January, this series of experiments was commenced. Calves Nos. 1 and 2, 5 and 6, and 8 and 9 received one feed of grass chopped in the

morning and nothing in the afternoon. Calf No. 4 was turned out and not considered. Calves Nos. 7 and 10 were allowed at liberty in the paddock to graze. No precautions were taken to keep them away from the vicinity of the pens containing the other animals feeding on *Lantana*. In fact they were observed more than once during the experiments to put their heads through the fence and drink water from the troughs within the pens containing the sick animals. This contact, without infection, increased their value as controls.

January 21*st*.—Calves Nos. 1 and 2, 5 and 6, 8 and 9 were fed *Lantana* and guinea grass in equal proportions, the weight of *Lantana* being 7 lb. This feed was not relished although about half the feed was eaten morning and evening.

January 22*nd*.—The same feed was given, slightly more being consumed at each feed.

January 23*rd*.—Calves Nos. 1 and 2 both showing disturbance of health, (calf No. 2 at the commencement showed signs of severe worm infestation, evidenced by unthriftiness, enlarged abdomen, œdema in submaxilliary region), not eating, constipation, grinding of teeth, shaking of head, mucoid discharge from nostrils and lacrymal discharge from eyes. Nos. 1 and 2 did not receive *Lantana* on this date and were subsequently given grass alone. Nos. 5 and 6, and 8 and 9 received the usual *Lantana* ration.

January 24*th*.—Calf No. 1 showed discharge from eyes, muzzle slightly inflamed with brownish-yellow exudate, Dermatitis affecting white parts of skin of back with exudation of yellowish serum matting the hair; animal constipated and restless, body screwed in a peculiar manner behind as though shrinking from pain, which it undoubtedly had at the time.

Calf No. 2, less prominent Dermatitis symptoms, but great depression and debility, constipated.

Calves Nos. 5 and 6 received no *Lantana* and were put on to guinea grass alone. These animals were showing no symptoms.

Calves Nos. 8 and 9 were continued on *Lantana* and were showing no symptoms.

January 25*th*.—Calf No. 1 showing Typical Dermatitis and the condition progressing.

Calf No. 2 was dead in the pen in the morning.

Autopsy.

Carcase emaciated, very slight inflammation of skin of white portion of muzzle. No lesions on skin, subcutaneous œdema marked, icterus, marked œdema of submaxilliary region, gelatinous and yellow. Pleural cavity contained pleuritic fluid clear yellow, adhesions between pulmonary and parietal pleura, slight pleurisy of old standing, œdema of base of lungs, pericardium, and mediastinal space. Parasitic pneumonia present (*Dictyocaulus viviparus*). Abdominal cavity contained about two litres yellowish clear fluid, rumen normal, omasum unusually dry content, abomasum slightly hæmorrhagic, intense infestation with *Hæmonchus contortus*, a few petechial hæmorrhages on great omentum; liver slightly smoky in colour; gall-bladder not enlarged but bile viscid and yellow-brown. Spleen normal, œdema about portal fissure. Perirenal tissue œdematous and icteric, no demonstrable fat present. Hilus of kidney œdematous and icteric. The icteric condition was present only in association with œdematous areas.

The findings of this autopsy cannot be said to be absolutely characteristic of the disease known as Dermatitis. Three findings, however, coincide, unusual dryness of the omasumal contents, viscid nature and colour of the bile and the tendency to general icterus. Four days after commencing to feed on *Lantana* this animal was dead. If this animal died from *Lantana* poisoning it is the earliest recorded death. Assuming that it did die from that cause I consider that the early onset of the disease and early death was due to the rapid action of the toxin on the debilitated animal, death occurring before the onset of typical symptoms of Dermatitis.

Calves Nos. 5 and 6, 8 and 9 not showing any symptoms. Nos. 8 and 9 were continued on *Lantana*. The control animals Nos. 7 and 10 showing no symptoms

January 26th.—Calf No. 1, disease progressing, emaciation, sunken eye, icterus, unpigmented skin devitilised, hard and yellowish-brown; urine frequently emitted in small quantities golden-brown in colour; constipation, muzzle yellowish-brown, dry smooth scab, becoming necrotic in area where nasal discharge was flowing over it, greyish in colour, small quantities of guinea grass eaten.

Calf No. 5 not eating, clear nasal discharge.

Calf No. 8 shaking the head, clear nasal discharge.

Calf Nos. 6 and 9 not showing any symptoms.

January 27th.—Calf No. 1, Typical Dermatitis, very depressed, not eating or drinking.

Calves Nos. 5 and 6 dull, not eating well.

Calf No. 8, muzzle swollen, slightly inflamed, clear discharge from nostrils, eyelids swollen, ears swollen over area of 1½ inches from the edge all around. Shaking of head, flapping of ears, grinding of teeth.

Calf No. 9, diarrhœa and emaciation, otherwise bright and no signs of Dermatitis.

January 28th.—Nos. 8 and 9 still continued on *Lantana*.

Calf No. 1, skin lesions drying up and hard.

Calf No. 8 more advanced Typical Dermatitis lesions.

Calves Nos. 5 and 6 showing slight symptoms, dulness, not eating. Urine rich yellow-brown colour. Watery discharge from nostrils. On No. 5 one spot on white area, one inch in diameter exuding yellow serum. Eyes slightly icteric.

Calf No. 9 not showing any signs of Dermatitis.

January 29th.—Calves Nos. 1, 5, 6, and 8 all showing Typical Dermatitis in varying degrees.

No. 9 no lesions.

January 30th.—No change.

January 31st.—Calf No. 1 very ill. All others liberated from pens to graze.

I would have been quite satisfied for the experiments to stop at this stage. The condition known as Dermatitis had been produced.

February 1st.—Calves Nos. 1, 5, 6, and 8 typical cases of Dermatitis.

Calf No. 9 not ill.

February 2nd.—Rain had fallen overnight and in the morning. At 2 p.m. the animals were inspected and No. 1 was found in a comatose state, just living. The attendant had thought the animal dead for three hours.

No. 5 was also found dead in the paddock.

Autopsys were held.

Calf No. 1, age 6 months, colour black and white, muzzle white.

Autopsy.

Calf No. 1, skin of white areas board-like, devitilised, hardness due to necrosis and drying of exuded serum on surface, loss of hair, yellowish-brown in colour, horns fallen off (early inflammation around base of horns noticed) coronitis. Legs and brisket very œdematous. Pigmented skin supple. Eyes sunken and icteric, gelatinous exudate present. Muzzle necrotic area over brownish-yellow scab. Subscutaneous tissue œdematous and icteric, almost orange yellow. Orange yellow serous exudate in peritoneal cavity. Intestines almost empty, but no marked inflammation. All stomachs fairly normal, no peeling of mucous membrance or marked inflammation. Liver 6 lb, yellowish-brown in colour, gall-bladder not markedly enlarged, about 400 c.c. bile, viscid. Kidney icteric especially in hilus. Lymp glands œdematous and icteric. Bladder distended to utmost with clear rich golden-brown urine. No catarrh of urethra. No congestion of sneiderian m.m. Carcase generally icteric. No body fat.

Calf No. 5, age 6 months, colour black and white, black muzzle, black pigmentation under the white hair. Skin lesions very slight, slight necrosis of skin of muzzle where mucous discharge had drained over muzzle. Rectum contained hard fæcis. Small erosion of gum in area $\frac{1}{4}$ inch square yellowish. Eye sunken and icteric. M.m. of mouth icteric. Inward lesions identical with those of No. 1. This calf did not show as marked symptoms as did No. 1. Liver weighed 6 lb.

February 3rd.—Calf No. 6 was found down in a comatose condition with heart beat bearly perceptable, respiration very slow and shallow. Animal was destroyed and an autopsy held.

Autopsy.

Colour black and white, black muzzle, black pigmented skin under the white hair, age 8 months. A few small areas of skin about the size of a shilling only were affected with a yellow serous exudate which had dried. Eyes sunken and icteric. Carcase emaciated. A continuation of this autopsy revealed lesions identical with those of No. 5. Liver weighed 6 lb.

Calf No. 8 was showing typical lesions, grazing a little but very dejected, cachectic.

Calf No. 9 showing no signs of Dermatitis, eating well, bowel motions softer than normal and condition poor. The eye bright and muzzle normal, cud chewing indulged in.

February 6th.—Calf No. 8 still alive, feeding a little but very cachectic, anterior nares almost occluded with dried mucous discharge. Areas of white skin devitilised, hard dry yellowish-brown in colour. Eyes sunken, icteric. The edges of the ears necrotic and recurving. Calf No. 9 still showing no signs of Dermatitis.

Feeding Experiment with Guinea Pig.

Owing to shortage of Guinea Pigs only one could be secured. This was a healthy, robust male about two years old. On the 27th January, he was

placed in a cage and fed a small quantity of *Lantana* tops. He was not observed to eat any of this, and so was practically starved for that day.

On the 28th he was again fed *Lantana* and was observed to eat a little.

On the 29th he was given a few shoots of grass with the *Lantana*, but was not observed to eat any *Lantana* but ate the grass. He appeared tucked up and soiled.

On the 30th, Guinea Pig ate a little grass but appeared dejected and had unclean coat, staring, eye watery and conjunctiva possibly faintest yellow.

February 1*st*.—The Guinea Pig found dead in its cage.

Autopsy.

Minute yellow specks on liver substance. Liver slightly enlarged, iteum hæmorrhagic, also large intestine. Inflammation of large intestine, constipation. The inflammation of the large intestine was the most prominent feature.

Death was due evidently to a toxæmia, whether a toxin from the *Lantana* or an autointoxication, one cannot say.

This latter experiment is in conclusive, in as much as that, although a previously healthy guinea pig died after eating *Lantana*, there was no control and one is not sure that the *Lantana* caused the death, although the evidence points that way.

Conclusion.

a. Probably one feed of *Lantana* of about 7 lb is sufficient to produce the disease, known as Dermatitis, in susceptiable animals.

b. Seven calves out of seven brought from Navua and fed *Lantana* contracted Dermatitis, hence it is safe to assume that all cattle not accustomed to the presence of *Lantana* amongst their grazing are susceptible, provided they eat it. The fact that only a percentage of animals brought to Suva contract Dermatitis naturally can be explained by assuming that only a per centage eat the plant although all are in contact with it.

c. The following facts indicate that Suva-bred animals are tolerant to the toxin of *Lantana*:—

1. Suva-bred animals (except small calves just commencing to graze) do not contract Dermatitis.
2. Eight Suva-bred animals experimentally fed *Lantana* in 1925 did not contract Dermatitis.
3. Calf No. 9, a Suva-bred animal, in the present series of experiments when continuously fed *Lantana*, did not contract Dermatitis whilst five Navua-bred calves receiving from one feed to many feeds in the same experiments, contracted the disease.

d. The condition known as Dermatitis affecting cattle in Fiji is caused by the ingestion of *Lantana camara* and in future the disease should be known as *Lantana* poisoning.

POLYARTHRITIS IN PIGS.

By W. G. Bennett, B.V.Sc., Government Veterinary Officer.

An outbreak of Polyarthritis in pigs, which is also known as Joint Ill, was investigated by Mr. T. T. McGrath, in February last at Ba.

This is a disease of young stock, not confined to pigs only but occurring also in calves, foals, and lambs. It is due to an infection by way of the umbilicus, with a widely distributed organism of the Pasteurella group, which exists in the soil in a similar manner to the tetanus bacillus, and tends to remain localised on the land where the disease occurs. Outbreaks of the disease occur in waves.

As the position and character of the umbilicus render it particularly easily soiled, special attention in the way of antiseptic dressings and cleanliness to this region are essential in young animals.

In the case under review, the disease manifested itself only among young pigs up to three weeks old, with typical symptoms, viz.: extreme weakness and emaciation, inability and lack of desire to take nourishment from the mother and general unthrifty appearance. Later the joints became hot and painfully swollen. On opening such swellings a caseous pus was found which, on microscopical examination revealed the presence of the Pasteurella organism. Abscesses also occurred in the umbilical region.

The outbreak at the Rarawai piggeries was no doubt due to a purely local infection of the soil, since it is of very rare occurrence in Fiji, and there is no probability of its becoming enzootic in this country.

Control Measures.

Treatment of this condition, as a rule, yields poor results, and preventive measures are much to be preferred. The first essential to prevention is cleanliness. When an animal is known to be due to litter it should be placed in a clean, dry stall with plenty of fresh air. New straw should be put down on the floor and care taken to see that drainage from the spot is good. The genital organs of the female should be dressed with an antiseptic solution, *e.g.*, 1 in 1,000 corrosive sublimate or 3 per cent. carbolic acid. The umbilical cord of the young should also be dressed with this solution and tied off with disinfected string as soon as the pulsations stop. Dressings should be continued until the umbilicus is completely dried up. The parturition box itself should be disinfected after each litter.

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